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O B S E R V A T I O N S
ON
MOUNT VESUVIUS,
MOUNT ETNA,
AND OTHER VOLCANOS:

I N
A S E R I E S O F L E T T E R S,

Addressed to THE ROYAL SOCIETY,
From the Honourable Sir W. HAMILTON,
K. B. F. R. S.

His Majesty's Envoy Extraordinary and Plenipotentiary
at the Court of NAPLES.

To which are added,
Explanatory NOTES by the AUTHOR,
hitherto unpublished.

T H E S E C O N D E D I T I O N.

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THE EDITOR

TO

THE PUBLIC.

HAVING mentioned to Sir WILLIAM HAMILTON the general Desire of all Lovers of Natural History, that his Letters upon the Subject of VOLCANOS should be collected together in one Volume, particularly for the Convenience of such as may have an Opportunity of visiting the curious Spots described in them : He was not only pleased to

A 2 approve

iv THE EDITOR TO THE PUBLIC.

approve of my having undertaken
this Publication, but has likewise
favoured with the additional explana-
tory Notes and Drawings,

The PUBLICK's most obliged,

and devoted

humble Servant,

T. CADELL.

May 30, 1772.

O B S E R-

ON THE CHANGES OF MOUNT VESUVIUS.

O B S E R V A T I O N S

ON
MOUNT VESUVIUS, &c.

L E T T E R I.

To the Right Honourable the Earl of Morton,
President of the Royal Society.

My L O R D, Naples, June 10, 1766.

A S I have attended particularly to the various changes of Mount Vesuvius, from the 17th of November 1764, the day of my arrival at this capital; I flatter myself, that my observations will not be unacceptable to your Lordship, especially as this Volcano has lately made a very considerable eruption. I shall confine my-

B self

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self merely to the many extraordinary appearances that have come under my own inspection, and leave their explanation to the more learned in Natural Philosophy.

During the first twelvemonth of my being here, I did not perceive any remarkable alteration in the mountain; but I observed, the smoke from the Volcano was much more considerable in bad weather than when it was fair [a]; and I often heard (even at Naples, six miles from Vesuvius) in bad weather, the inward ex-

[a] Having reflected since upon this circumstance, I rather believe that the weight of the atmosphere in bad weather, preventing the free dissipation of the smoke, and collecting it over the crater, gives it the appearance of being more considerable; whereas in fine weather the smoke is dispersed soon after its emission. It is, however, the common-received opinion at Naples (and from my own observation is, I believe, well founded), that when Vesuvius grumbles, bad weather is at hand. The sea of the Bay of Naples, being particularly agitated and swelling some hours before the arrival of a storm, may very probably force itself into crevices, leading to the bowels of the Volcano, and, by causing a new fermentation, produce those explosions and grumblings.

explosions

MOUNT VESUVIUS, &c. 3

plorations of the mountain. When I have been at the top of Mount Vesuvius in fair weather, I have sometimes found so little smoke, that I have been able to see far down the mouth of the Volcano; the sides of which were incrusted with salts and mineral of various colors, white, green, deep and pale yellow. The smoke that issued from the mouth of the Volcano in bad weather was white, very moist, and not near so offensive as the sulphureous steams from various cracks on the sides of the mountain.

Towards the month of September last, I perceived the smoke to be more considerable, and to continue even in fair weather; and in October I perceived sometimes a puff of black smoke shoot up a considerable height in the midst of the white, which symptom of an approaching eruption grew more frequent daily; and soon after, these puffs of smoke appeared in the night tinged like clouds with the setting sun.

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About the beginning of November, I went up the mountain: it was then covered with snow; and I perceived a little hillock of sulphur had been thrown up, since my last visit there, within about forty yards of the mouth of the Volcano; it was near six feet high, and a light blue flame issued constantly from its top. As I was examining this phænomenon, I heard a violent report; and saw a column of black smoke, followed by a reddish flame, shoot up with violence from the mouth of the Volcano; and presently fell a shower of stones, one of which, falling near me, made me retire with some precipitation, and also rendered me more cautious of approaching too near, in my subsequent journeys to Vesuvius.

From November to the 28th of March, the date of the beginning of this eruption, the smoke increased, and was mixed with ashes, which fell, and did great damage to the vineyards in the neighbourhood of the

the mountain [6]. A few days before the eruption I saw (what Pliny the younger mentions having seen, before that eruption of Vesuvius which proved fatal to his uncle) the black smoke take the form of a pine-tree. The smoke, that appeared black in the day-time; for near two months before the eruption, had the appearance of flame in the night.

On Good Friday, the 28th of March, at 7 o'clock at night, the lava began to boil over the mouth of the Volcano, at first in one stream; and soon after, dividing itself into two, it took its course towards Portici. It was preceded by a violent explosion, which caused a partial earthquake in the neighbourhood of the mountain; and a shower of red hot stones and

[6] These ashes destroy the leaves and fruit, and are greatly detrimental to vegetation for a year or two; but are certainly of great service to the land in general, and are among the principal causes of that very great fertility which is remarkable in the neighbourhood of Volcano's.

cinders were thrown up to a considerable height. Immediately upon sight of the lava, I left Naples, with a party of my countrymen, whom I found as impatient as myself to satisfy their curiosity in examining so curious an operation of nature. I passed the whole night upon the mountain; and observed that, though the red hot stones were thrown up in much greater number and to a more considerable height than before the appearance of the lava, yet the report was much less considerable than some days before the eruption. The lava ran near a mile in an hour's time, when the two branches joined in a hollow on the side of the mountain, without proceeding farther. I approached the mouth of the Volcano, as near as I could with prudence; the lava had the appearance of a river of red-hot and liquid metal, such as we see in the glass-houses, on which were large floating cinders, half-lighted, and rolling one over another, with great precipitation down the side of the mountain, forming a most beautiful

beautiful and uncommon cascade ; the colour of the fire was much paler and more bright the first night than the subsequent nights, when it became of a deep red, probably owing to its having been more impregnated with Sulphur at first than afterwards. In the day-time, unless you are quite close, the lava has no appearance of fire ; but a thick white smoke marks its course.

The 29th, the mountain was very quiet, and the lava did not continue. The 30th, it began to flow again in the same direction, whilst the mouth of the Volcano threw up every minute a girandole of red hot stones, to an immense height. The 31st, I passed the night upon the mountain : the lava was not so considerable as the first night ; but the red hot stones were perfectly transparent, some of which, I dare say of a ton weight, mounted at least two hundred feet perpendicular, and fell in, or near, the mouth of a little mountain, that was now formed by the quantity

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of ashes and stones, within the great mouth of the Volcano, and which made the approach much safer than it had been some days before; when the mouth was near half a mile in circumference; and the stones took every direction. Mr. Hetvey, brother to the Earl of Bristol, was very much wounded in the arm some days before the eruption, having approached too near; and two English gentlemen with him were also hurt. It is impossible to describe the beautiful appearance of these girandoles of red hot stones, far surpassing the most astonishing artificial fire-work.

From the 31st of March to the 9th of April, the lava continued on the same side of the mountain, in two, three, and sometimes four branches, without descending much lower than the fifth night. I remarked a kind of intermission in the fever of the mountain[s], which seemed to be this period, and the present to return again. In the subsequent eruptions of Vesuvius, I have constantly remarked something of the same nature, as appears in my account of the great eruption of 1767.

I have

return with violence every other night.
On the 29th of April, at night, the lava
disappeared on the side of the mountain
towards Naples, and broke out with much
more violence on the side near the *grotto
del' Annunziata*.

I passed the whole day and the night
of the 30th upon the mountain, and fol-
lowed the course of the lava to its very
source : it burst out of the side of the
mountain, within about half a mile of the
mouth of the Volcano, like a torrent, ac-
tended with violent explosions, which threw
up inflamed matter to a considerable
height, the adjacent ground quivering like
the timbers of a water-mill ; the heat of
the lava was so great, as not to suffer me

I have found the same remark in many accounts of
former eruptions of Vesuvius : in the very curious one
of the formation of a new mountain near Puzzole, in
1538, (as may be seen in my letter to Dr. Maty, Oct. 16,
1770,) the same observation is made. This phenomenon
is well worthy of a curious inquiry, which might give
some light into the theory of the earth, of which, I be-
lieve, we are very ignorant.

• See p. 103. of this collection.

to

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to approach nearer than within ten feet of the stream, and, of such a consistency (though it appeared liquid as water) as almost to resist the impression of a long stick, with which I made the experiment; large stones thrown on it with all my force did not sink, but, making a slight impression, floated on the surface, and were carried out of sight in a short time; for, notwithstanding the consistency of the lava, it ran with amazing velocity; I am sure, the first mile with a rapidity equal to that of the river Severn, at the passage near Bristol. The stream at its source was about ten feet wide, but soon extended itself, and divided into three branches; so that these rivers of fire, communicating their heat to the cinders of former lavas, between one branch and the other, had the appearance at night of a continued sheet of fire, four miles in length, and in some parts near two in breadth. Your Lordship may imagine the glorious appearance

pearance of this uncommon scene, such as
passes all description.

The lava, after having run pure for
about a hundred yards, began to collect
cinders, stones, &c., and a scum was formed
on its surface, which in the day-time
had the appearance of the river Thames,
as I have seen it after a hard frost and
great fall of snow, when beginning to
thaw, carrying down vast masses of snow
and ice. In two places the liquid lava
totally disappeared, and ran in a subter-
raneous passage for some paces; then came
out again pure, having left the scum be-
hind. In this manner it advanced to the
cultivated parts of the mountain; and I
saw it, the same night of the 12th, un-
mercifully destroy a poor man's vineyard,
and surround his cottage, notwithstanding
the opposition of many images of St.
Januarius, that were placed upon the cot-
tage, and tied to almost every vine. The
lava, at the farthest extremity from its
source, did not appear liquid, but like a
heap

heap of red-hot coals, forming a wall in some places ten or twelve feet high, which rolling from the top soon formed another wall, and so on, advancing slowly, not more than about thirty feet in an hour [d].

[d] I am convinced, that it might be very practicable to divert the course of a lava when in this state, by preparing a new bed for it, as is practised with rivers. I was mentioning this idea at Catania in Sicily, when I was assured, that it had been done with success during the great eruption of Etna, in 1669; that the lava was directing its course towards the walls of Catania, and advancing slowly like the abovementioned, when they prepared a channel for it round the walls of the town, and turned it into the sea; that a succession of men, covered with sheep-skins wetted, were employed to cut through the tough flanks of the lava, till they made a passage for that in the centre (which was in perfect fusion) to disgorge itself into the channel prepared for it. A book I have since met with gives the same account of this curious operation; it is intituled, *Relazione del nuovo incendio fatto da Mongibello, 1669.* Messina, Giuseppe Bisogni, 1670. His Sicilian Majesty's palace at Portici, and the valuable collection of antiquities that have been recovered from beneath the destructive lavas of Vesuvius, are in imminent danger of being overwhelmed again by the next that shall take its course that

The mouth of the Volcano has not thrown up any large stones since the second eruption of lava on the 10th of April; but has thrown up quantities of small ashes and pumice stones, that have greatly damaged the neighbouring vineyards. I have been several times at the mountain since the 12th; but, as the eruption was in its greatest vigour at that time, I have ventured to dwell on, and I fear tire your Lordship with, the observations of that day.

In my last visit to Mount Vesuvius, the 3d of June, I still found that the lava continued; but the rivers were become rivulets, and had lost much of their rapidity. The quantity of matter thrown out by this eruption is greater than that of the last in the year 1760; but the da-

that way; whereas, by taking a level, cutting away and raising ground, as occasion might require, the palace and museum would, in all probability, be insured, at least against one eruption; and, indeed, I once took the liberty of communicating this idea to the King of Naples, who seemed to approve of it.

image

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image to the cultivated lands is not so considerable, owing to its having spread itself much more, and its source being at least three miles higher up. This eruption seems now to have exhausted itself; and I expect in a few days to see Vesuvius restored to its former tranquillity.

Mount Etna in Sicily broke out the 27th of April; and made a lava, in two branches, at least six miles in length, and a mile in breadth; and, according to the description given me by Mr. Wilbraham, (who was there, after having seen with me part of the eruption of Mount Vesuvius) resembles it in every respect, except that Mount Etna, at the place from whence the lava flowed (which was twelve miles from the mouth of the Volcano), threw up a fountain of liquid inflamed matter to a considerable height; which, I am told, Mount Vesuvius has done in former eruptions.

I beg pardon for having taken up so much of your time; and yet I flatter myself,

MOUNT VESUVIUS, &c. 15

self, that my description, which I assure your Lordship is not exaggerated, will have afforded you some amusement. I have the honour to be,

My LORD,

Your Lordship's

Most obedient

and most humble servant,

WILLIAM HAMILTON.



Naples, February 3, 1767.

SINCE the account of the eruption of Mount Vesuvius, which I had the honour of giving to your Lordship, in my letter of the 10th of June last; I have only to add, that the lava continued till about the end of November, without doing any great damage, having taken its course over ancient

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tient lavas. Since the cessation of this eruption, I have examined the crater, and the crack on the side of the mountain, towards *Torre dell' Annunziata*, about a hundred yards from the crater from whence this lava issued: and I found therein some very curious salts and sulphurs; a specimen of each sort I have put into bottles myself, even upon the mountain, that they might not lose any of their force, and have sent them in a box directed to your Lordship, as you will see by the bill of lading: I am sure, you will have a pleasure in seeing them analyzed [s]. I have also packed in the same box some lava, and cinders, of the last eruption; there is one piece in particular very curious, having the exact appearance of a cable petrified. I shall be very happy if these trifles should af-

[s] The late Lord Morton was pleased to give these specimens to Dr. Morris, who has made several chemical experiments on them, the result of which will be communicated to the Royal Society.

ford

feed your Lordship a moment's amusement.

It is very extraordinary, that I cannot find, that any chemist here has ever been at the trouble of analyzing the productions of Vesuvius.

The deep yellow, or orange-color salts, of which there are two bottles, I fetched out of the very crater of the mountain, in a crevice that was indeed very hot. It seems to me to be powerful, as it turns silver black in an instant, but has no effect upon gold. If your Lordship pleases, I will send you by another opportunity specimens of the sulphurs and salts of the Solfa terra, which seem to be very different from these.

Within these three days, the fire has appeared again on the top of Vesuvius, and earthquakes have been felt in the neighbourhood of the mountain. I was there on Saturday with my nephew Lord Grenville; we heard most dreadful inward grumblings, rattling of stones, and hissing;

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and were obliged to leave the crater very soon, on account of the emission of stones. The black smoke arose, as before the last eruption; and I saw every symptom of a new eruption, of which I shall not fail to give your Lordship an exact account.

HOTEL - **INN** - **RESORT** - **MOTEL**

VIEW OF THE Eruption OF
MOUNT VESUVIUS,
AS IT APPEARED TO THE AUTHOR,
ON THE 29TH OF NOVEMBER,
OR LIST OF LETTERS II.

To the Right Honourable the Earl of MORTON,
President of the Royal Society.

My LORD, Naples, December 29, 1767.

THE favourable reception, which my account of last year's eruption of Mount Vesuvius met with from your Lordship; the approbation which the Royal Society was pleased to shew, by having ordered the same to be printed in their Philosophical Transactions; and your Lordship's commands, in your letter of the 3d instant; encourage me to trouble you with a plain narrative of what came immediately under my observation, during the late violent eruption, which began October 19, 1767, and is reckoned to be the twenty-seventh since that, which, in the

time of Titus, destroyed Herculaneum and Pompeii.

The eruption of 1766 continued in some degree till the 10th of December, about nine months in all [f.] ; yet in that space of time the mountain did not cast up a third of the quantity of lava, which it disgorged in only seven days, the term of this last eruption. On the 15th of December, last year, within the ancient crater of Mount Vesuvius, and about twenty

[f.] From what I have seen, and read of eruptions of Vesuvius and Etna, I am convinced that Volcano's dormant for several years, say even for tenturies, as probably was the case of Vesuvius before its eruption in the reign of Titus, and certainly was so before that of the year 1631. When I arrived at Naples in 1764, Vesuvius was quiet, very seldom smoke was visible on its top; in the year 1766, it seemed to take fire, and has never since been three months without either throwing up red hot stones, or disgorging streams of lava, nor has its crater been ever free from smoke. At Naples, when a lava appears, and not till then, it is styled an eruption; whereas I look upon the five previous eruptions, I have been witness to, from March 1766 to May 1771, as, in effect, but one continued eruption.

feet

feet deep; there was a crust, which formed a plain, not unlike the Solfa terra in magnitude; in the midst of this plain was a little mountain, whose top did not rise so high as the rim of the ancient crater. I went into this plain, and up the little ascent path, which was perforated, and served as the principal chimney to the Volcano; when I threw down large stones, I could hear that they met with many obstructions in their way, and could doubt a hundred moderately before they reached the bottom.

Vesuvius was quiet till March 1767, when it began to throw up stones from time to time; in April, the throws were more frequent, and at night fire was visible on the top of the mountain; or, more properly speaking, the smoke, which hung over the crater, was tinged by the reflection of the fire within the Volcano. These repeated throws of cinders, ashes, and powdered stones, increased the little mountain so much, that in May its top was visible above the rim of the ancient crater.

crater. The 7th of August, there issued a small stream of lava, from a breach on the side of this little mountain, which gradually filled the valley between it and the ancient crater; so that, the 10th of September, the lava overflowed the ancient crater, and took its course down the sides of the great mountain; by this time, the throws were much more frequent, and the red hot stones went so high as to take up ten seconds in their fall. Padre Torte, a great observer of Mount Vesuvius, says they went up above a thousand feet.

The 15th of October, the height of the little mountain (formed in about eight months) was measured by Don Andrea Piganati, a very ingenious young man, in His Sicilian Majesty's service, who assured me that its height was 185 French feet.

From my villa, situated between Herculaneum and Pompeii, near the connoct of the Calmadolese (marked 7 in Plate I.) I had watched the growing of this little mountain; and, by taking drawings of it

from

from time to time, I could perceive its incrustations minutely. I make no doubt but that the whole of Mount Vesuvius has been formed in the same manner; and as these observations seem to me to account for the various irregular strata, which are seen with in the neighbourhood of Naples, I have ventured to inclose, for your Lordship's inspection, a copy of the above-mentioned drawings, (Plate III.)

The lava continued to run over the adjacent crater in small streams, sometimes on one side, and sometimes on another, till the 18th of October, when I took particular notice that there was not the least slate to be seen, owing, I imagine, to its being employed in forcing its way towards the place where it burst out the following day; As I had, contrary to the opinion of most people here, foretold the approaching eruption [y], and had observed a (I easily discerned) smoky appearance [g]. It is certain, that, by constant attention to the smoke that issues from the crater, a very good guess may be given at to the degree of fermentation within.

great fermentation in the mountain after the heavy rains, which fell the 13th and 14th of October; I was not surprised, on the 19th following, at eleven of the clock in the morning, to perceive from my villa every symptom of the eruption being just at hand. From the top of the little mountain issued a thick black smoke, so thick that it seemed to have difficulty in forcing its way out; cloud after cloud mounted with a hasty spiral motion, and every minute a volley of great stones were shot up to an immense height in the midst of these clouds; by degrees, the smoke

the Volcano. By this alone I foretold* the two last eruptions, and, by another very simple observation, I pointed out, some time before, the very spot from whence the lava has issued. When the cone of Vesuvius was covered with snow, I had remarked a spot on which it would not lie: considering very naturally that this was the weakest part of the cone, and that the heat from within prevented the snow from lying; it was as natural to imagine that the lava, seeking a vent, would force this passage sooner than another; and so indeed it came to pass.

* See Letter B. 1807. It is difficult to determine exactly when the eruption took place.

and the exact shape of a huge pine-tree, which, as Pliny the younger describes in his letter to Tacitus, where he gives an account of the fatal eruption in which his uncle perished [4]. This column of black smoke, after having mounted an extraordinary height, bent with the wind towards Capri, and actually reached over that island, which is not less than twenty-eight miles from Vesuvius; so as on . . . I warned my family, not to be alarmed, as I expected there would be an earth-quake at the moment of the lava's bursting out; but, before eight of the clock in the morning, I perceived that the mount

[4] These are his words: " Nubes incertum procul intuens ex quo monte Velutum fuisse posita longiora et quiebant, et in similitudine forent, tamen, non alia, magis arbor, quam pumice expellere. Nam longissimo veluti trunco, elata in altum, qui subiectam rami diffundebatur, credo quia recenti spiritu ex eisdem deinde rescente eo definita, aufestet ponde-
re suo vix in latitudinem evaderebat; condensata
dum, ingens sordida & maculosa prout tegat
cineremve fultulerat." Plin. lib. vi. ep. 16.

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which had opened a mouth, without noise, about a hundred yards lower than the ancient crater, on the side towards the Monte di Somma; and I plainly perceived, by a white smoke, which always accompanies the lava, that it had forced its way out; as soon as it had vent, the smoke no longer came out with that violence from the top. As I imagined that there would be no danger in approaching the mountain when the lava had vent, I went up immediately, accompanied by one peasant only. I passed the hermitage (3. in Plate I.), and proceeded as far as the spot marked (X), in the valley between the mountain of Somma and that of Vesuvius, which is called Atrio di Cavalli, and was making my observations upon the lava, which had already, from the spot (E) where it first broke out, reached the valley; when, on a sudden, about noon, I heard a violent noise within the mountain, and at the spot (C), about a quarter of a mile off the place where I stood, the mountain split; and,

and with much noise, from this downwardly a fountain of liquid fire shot up many feet high. And a sheny like a torrent, rolled on directly towards us. The earth shook; at the same time thus a volley of pumice stones fell thick upon us; in an instant clouds of black smoke and ashes covered almost a total darkness; the explosions from the top of the mountain were much louder than any thunder I ever heard; and the smell of the sulphur was very offensive. My guide, alarmed, took to his heels; and I must confess, that I was not at my ease.⁽³⁾ I followed close, and we ran near three miles without stopping; as the earth continued to shake under our feet, I was apprehensive of the opening of a fresh mouth, which might have cut off our retreat. I also feared that the violent explosions would detach some of the rocks off the mountain of Somma, under which we were obliged to pass; besides, the pumice-stones, falling upon us like hail, were of such a size as to cause a disagreeable sensation.

sensation upon the path whereon they were. After having taken refreshment, as she could still tremble greatly, I thought it most prudent to leave the mountain; and we returned to my villa, where I saw to my daily惊 in a great alarm, at the continual and violent explosions of the Volcano, which shook our house to its very foundation, the doors and windows swinging upon their hinges. About two o'clock in the afternoon another day started us wide out of the same place from whence we came the Java last year, at the spot marked B (see Plate II); so that the configuration was soon as great on this side of the mouth of the river, as on the other, which I had just left. The noise and smell of sulphuric smoke, carried away from our villa to Naples, I thought proper, as I passed by Portici to inform the Court of what I had seen, and humbly offered it at my opinion, that His Sicilian Majesty should leave the neighbourhood of the threatening mountain. However the Court did not

not leave Puglia till about twelve of the clock, when the lava had reached so far as (as in Plate A) — I observed, in my way to Naples, which was in less than two hours after I had left the mountain, that the lava had actually covered three miles of the very road through which we had retreated. It is astonishing that it should have run so fast, as I have since seen, that the river of lava, in the Arno di Gavazzo, was sixty and forty feet deep, and in some places near thirty broad. When his Sicilian Majesty visited Puglia, the noise was greatly increased, and the concussion of the air from the explosions was so violent, that, in the King's palace, doors and windows were forced open; and even one door there, which was locked, was Steven-thinly burst open. At Naples, the same night, many windows and doors flew open in my house, which is not on the side of the volcano, near Vesuvius. I tried the experiments of unbolting my windows [?].

(The windows at Naples open like folding doors)
when

when they flew wide open upon every explosion of the mountain. Besides these explosions, which were very frequent, there was a continued tremulous and violent rumbling noise, which lasted this night about five hours. I have imagined, that this extraordinary noise might be owing to the lava in the bowels of the mountain having met with a deposition of rain-water, and that the conflict between the fire and the water may, in some measure, account for so extraordinary a crackling and hissing noise. Padre Torre, who has wrote so much and so well upon the subject of Mount Vesuvius, is also of my opinion. And indeed it is natural to imagine, that there may be rain-water lodged in many of the caverns of the mountain; as, in the great eruption of Mount Vesuvius in 1631, it is well attested, that several towns, among which Portici and Torre del Greco, were destroyed, by a torrent of boiling water having burst out of the mountain with the lava, by which thousands of lives

lives were lost. About four years ago, Mount Etna in Sicily threw up hot water also, during an eruption.

The confusion at Naples this night cannot be described; his Sicilian Majesty's hasty retreat from Portici added to the alarm; all the churches were opened and filled, the streets were thronged with processions of saints: but I shall avoid entering upon a description of the various ceremonies that were performed in this capital, to quell the fury of the turbulent mountain.

Tuesday the 20th, it was impossible to judge of the situation of Vesuvius, on account of the smoke and ashes, which covered it entirely, and spread over Naples also, the sun appearing as through a thick London fog, or a smoked glass; small ashes fell all this day at Naples. The lava on both sides of the mountain ran violently; but there was little or no noise till about nine o'clock at night, when the same uncommon rumbling began again, accom-

accompanied with explosion as before; which lasted about four hours; it seemed as if the mountain would split in pieces and, indeed, it裂了, though almost from the spot E to C (in Plate I.)e; The annexed photos were taken upon the spot in this issue, when the lava was at their heights and does not thicken, crust, or generate. At the flattened banister area, as yesterday, at about , and in diameter, at 70 degrees; whereas, for some days preceding the eruption, it had been at 65 and 66. During the confusion of this night, the prisoners in the public jail attempted to escape, having impeded the jailor; but were prevented by the archbishop. The monk also set fire to the Cardinal Archibishop's gate, because he refused to bring out the relics of Saint Lazarus.

Wednesday 21st, was more quiet than the preceding days, though the lava ran briskly. Belpai was once in some danger, had not the lava taken a different course

coarse; when it was only a mile and a half from it; towards night, the lava slackened.

Thursday 22d, about ten of the clock in the morning, the same thundering noise began again, but with more violence than the preceding days; the oldest men declared, they had never heard the like; and, indeed, it was very alarming: we were in expectation every moment of some dire calamity. The ashes, or rather small cinders, showered down so fast, that the people in the streets were obliged to use umbrellas, or flap their hats; these ashes being very offensive to the eyes. The tops of the houses, and the balconies, were covered above an inch thick with these cinders [k].

[k] In several accounts of former eruptions of Vesuvius, I have found mention of the ashes falling at a much greater distance; that, in the year 472 and 473, they had reached Constantinople: Dio faya, that during the eruption of Vesuvius in the time of Titus—“tantus fuit pulvis ut ab eo loco in Africam et Syriam “et Aegyptum penetraverit.” A book printed at Lecce, in the kingdom of Naples, in MDCXXXII, and intituled, *Discorso sopra l'origine de fuochi gettati dal Monte Vesuvio*

Ships at sea, twenty leagues from Naples, were also covered with them, to the great

di Giò Francesco Serrata Spinola Galateo, says, that the 16th of December, 1631, the very day of the great eruption of Vesuvius (though perfectly calm), it rained ashes at Lecce, which is nine days journey from the mountain: that the day was darkened by them, and that they covered the ground three inches deep; that ashes of a different quality fell at Bari the same day; and that at both these places the inhabitants were very greatly alarmed, not being able to conceive the occasion of such a phænomenon. Antonio Bulifon, in his account of the same eruption, says, that the ashes fell, and lay several inches deep at Ariano in Puglia; and I have been assured, by many persons of credit at Naples, that they have been sensible of the fall of ashes, during an eruption, at above two hundred miles distance from Vesuvius. The Abbate Giulio Cesare Bracini, in his account of the eruption of Vesuvius, in 1631, says, that the height of the column of smoke and ashes, taken from Naples by a quadrant, was upwards of thirty miles. Though such uncertain calculations demand but little attention; yet, by what I have seen, I am convinced, that in great eruptions the ashes are sent up to so great a height as to meet with extraordinary currents of air, which is the most probable way of accounting for their having been carried to so great a distance in a few hours. In a book, intituled, *Salvatoris Varonis Vesuviani incendii Libri tres: Neapoli*, astonish-

astonishment of the sailors. In the midst of these horrors, the mob, growing tumultuous and impatient, obliged the Cardinal to bring out the head of Saint Januarius, and go with it in procession to the Ponte Maddalena, at the extremity of Naples, towards Vesuvius; and it is well attested here, that the eruption ceased the moment the Saint came in sight of the mountain; it is true, the noise ceased about that time, after having lasted five hours, as it had done the preceding days.

Friday 23d, the lavas still ran, and the mountain continued to throw up quantities of stones from its crater; there was no noise heard at Naples this day, and but little ashes fell there.

MDXXXIV. I found a very poetical description of the ashes that lay in the neighbourhood of Vesuvius, after the eruption of 1631, in depth, from twenty to a hundred palms: "Quare," says this author, "multi patrio
" in solo requirunt patriam, et vix ibi se credunt vivere
" ubi certo sciant fere natos, adeo totam loci speciem
" tempestas vertit."

D 2

Saturday

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Saturday 24th, the lava ceased running; the extent of the lava, from the spot C (Plate I.), where I saw it break out, to its extremity F, where it surrounded the chapel of Saint Vito, is above six miles. In the Atrio di Cavallo, and in a deep valley that lies between Vesuvius (1.) and the hermitage (3.), the lava is in some places near two miles broad, and in most places from sixty to seventy feet deep; at (4.), the lava ran down a hollow way, called Fossa grande, made by the currents of rain water; it is not less than two hundred feet deep, and a hundred broad; yet the lava in one place has filled it up. I could not have believed that so great a quantity of matter could have been thrown out in so short a time, if I had not since examined the whole course of the lava myself. This great compact body will certainly retain some heat many months [I]; at this time,

[I] This conjecture has proved true; for, even in the month of April 1771, I again thrust sticks into some crevices of this lava, and they immediately took fire. On much

much rain having fallen for some days past, the lava smoaks, as if it ran afresh: and about ten days ago, when I was up the mountain with Lord Stormont, we thrust sticks into the crevices of the lava, which took fire immediately: But to proceed with my journal.

The 24th, Vesuvius continued to throw up stones as on the preceding days: during the whole of this eruption, it had differed in this circumstance from the eruption of 1766, when no stones were thrown out of the crater from the moment the lava ran freely.

Sunday 25th, small ashes fell all day at Naples; they issued from the crater of the Volcano, and formed a vast column, as black as the mountain itself, so that the shadow of it was marked out on the surface of the sea; continual flashes of forked or zig-zag lightning shot from this black column, the thunder of which was heard

Mount Etna, in 1769, I observed the lava, that had been disgorged in 1766, smoak in many parts.

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in the neighbourhood of the mountain, but not at Naples: there were no clouds in the sky at this time, except those of smoak issuing from the crater of Vesuvius. I was much pleased with this phænomenon, which I had not seen before in that perfection [m].

[m] In all accounts of great eruptions of Mount Etna and Mount Vesuvius, I have found mention of this sort of lightning. Pliny the younger, in his second letter to Tacitus upon the eruption of Vesuvius in the time of Titus, says, that a black and horrible cloud covered them at Misenum (which is above fifteen miles from the Volcano), and that flashes of zig-zag fire, like lightning, but stronger, burst from it; these are his words: "ab altero latere nubes atra et horrida
 "ignei spiritus tortis vibratique discursibus rupta, in
 "longas flammarum figuram dehiscebat; fulgoribus
 "ille et similes et maiores erant." This was evidently the same electrical fire; and with which I am convinced that the smoak of all Volcanos is pregnant. In several accounts of the great eruption of Vesuvius in 1631, mention is made of damage done by the lightning that issued from the column of smoak. Bulifon, in particular, says, that, in the neighbourhood of the Volcano, people were struck dead in the same manner as if by lightning, without having their cloaths singed. Pliny mentions a like instance,

Monday

Monday 26th; the smoke continued, but not so thick, neither were there any flashes of the mountain lightning. As no lava has appeared after this column of black smoke, which must have been occasioned by some inward operation of fire; I am apt to think, that the lava, which should naturally have followed this symptom, has broke its way into some deeper cavern, where it is silently brooding future mischief; and I shall be much mistaken, if it does not break out a few months hence.

Tuesday 27th, no more black smoke, nor any signs of eruption.

which shews that the ancients had observed this phenomenon; for he says, that at Pompeii, the day being fair, Marcus Herennius was struck dead by lightning. These are his words; "In Catilinais prodigiis, Pompei periano ex municipio M. Herennius Decario ferens "die, fulmine ihsus est." Plin. Hist. Nat. lib. II. cap. 11. The learned and ingenious Father Beccaria, at Turin, assured me, that he had been greatly pleased with my observations on this species of lightning, as coinciding perfectly with several of his electrical experiments,

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Thus, my Lord, I have had the honor of giving your Lordship a faithful narrative of my observations during this eruption; which is universally allowed to have been the most violent of this century; and I shall be happy, if it should meet with your approbation, and that of the Royal Society, if your Lordship should think it worthy of being communicated to so respectable a body.

I have just sent a present to the British Museum of a complete collection of every sort of matter produced by Mount Vesuvius, which I have been collecting with some pains for these three years past; and it will be a great satisfaction to me, if, by the means of this collection, some of my countrymen, learned in natural history, may be enabled to make some useful discoveries relative to Volcanos [n].

[n] "I am well convinced, by this collection, that many variegated marbles, and many precious stones, are the produce of Volcanos; and that there have been Volcanos in many parts of the world, where

I have

MOUNT VESUVIUS, &c. 42.

I have also accompanied that collection with a view of a current of lava from Mount Vesuvius; it is painted with transparent colours, and, when lighted up with lamps behind it, gives a much better idea of Vesuvius, than is possible to be given by any other sort of painting.

I have the honor to be,

My LORD,

Your Lordship's

Most obedient

and most humble servant,

WILLIAM HAMILTON.

"present there are no traces of them visible." This is taken from a prior letter to Lord Morton, dated April 7, 1767.

PLATE

PLATE I.

A. Crater of Mount Vesuvius.
 B. Mouth from whence came the lava
 of 1766; and which opened afresh,
 October 19, 1767, and produced
 the conflagration represented in
 Plate II.

C. The mouth which opened at 12
 o'clock, October 19, 1767, whilst
 I was at the spot marked X; from
 thence came all the lava represent-
 ed in Plate I.

D. The lava.

E. Mouth from whence the lava flow-
 ed at eight o'clock, October 19,
 when the eruption began first.

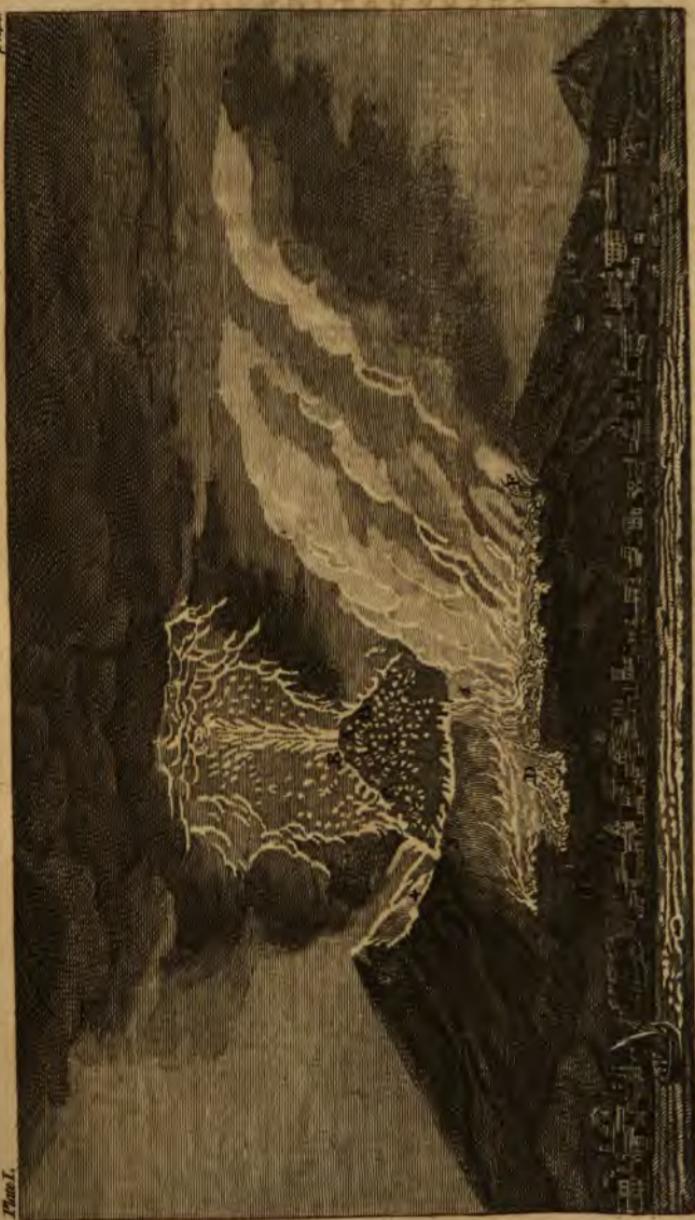
F. Chapel of Saint Vito, surrounded
 with lava.

1. Vesuvius.
 2. Mountain of Somma,

3. Her-

View of the GREAT ERUPTION of VESUVIUS 1767 from Portici.

Pl. L.



Pl. L.







View of the GREAT ERUPTION of VESUVIUS 1767, from Torre dell'Annunziata.

3. Hermitage, between which and Vesuvius there is a deep valley two miles broad,
4. The Fossa Grande,
5. His Sicilian Majesty's Palace at Portici.
6. Church of Pugliano.
7. Calmoldolese Convent, near which is my Villa.
8. Saint Jorio.
9. Barra.
10. Spot, under which lies Herculaneum.

P L A T E I I.

A. Crater of Vesuvius.

B. Mouth, from whence came the lava of 1766, and which opened afresh at two o'clock, October 19, 1767, and caused the conflagration on this side of the mountain.

C. Mouth which opened at 12 o'clock, October 19, 1767, whilst I was at the

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the spot X, and, which produced all
the lava represented in Plan I.

D. Rivulets of lava, which flowed from
the crater, and united with the great
river E.

F. Extremities of the lava, about five
miles from B.

1. Mountain of Somma.
2. Mount Vesuvius.
3. Montagna di Trecase.
4. Trecase.
5. Oratorio di Bosco.
6. Ottiano.

P L A T E III.

Views of the gradual increase of the little
mountain within the ancient crater;
and of the present shape of Mount
Vesuvius.

L E T.

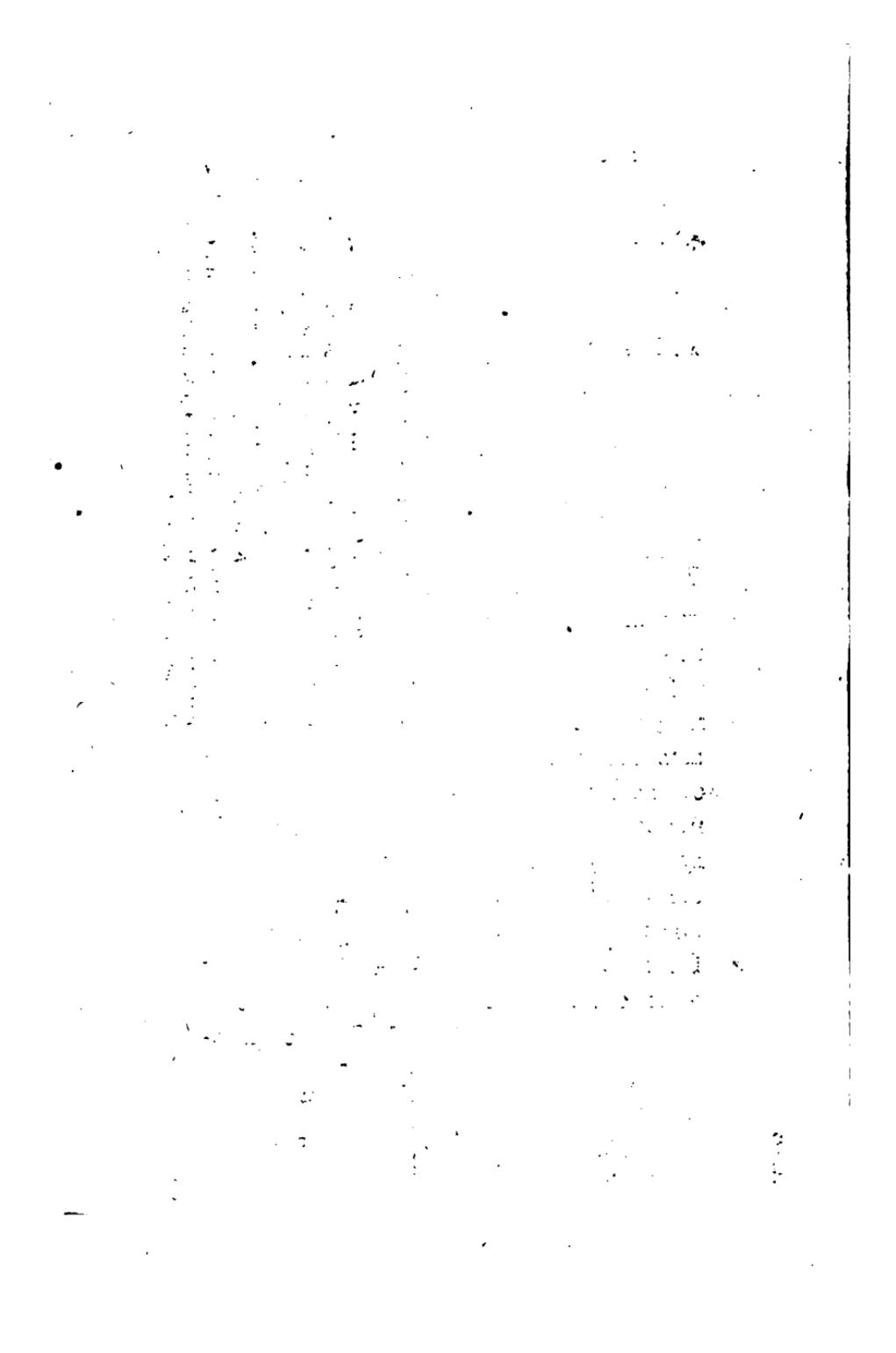
Plate II.



*The ancient Crater of Mount Vesuvius,
With the greatest source of the little streams within the Crater.*

The exterior walls of the mouth and base of the volcano stand like the rocks of the little Mountain higher than increase, so that the declivity in the Drifts of Vesuvius forms the side of the little Mountain high; the little spouts, mostly where the lava comes out, are always higher before the great Eruption. A.C.D. near the ancient crater A.E. the little Mountain's declivity, above the Eruption. E.G. is the present Crater. H. the exterior Mouth for H.E.C. the present shape of the top of Mount Vesuvius. Directly over the Mountain's declivity
H.A.E. which is near 200 feet.





LETTER III.

To MATHEW MATY, M. D. Secretary to
the Royal Society.

Villa Angelica, near Mount Vesuvium,
October 4, 1768.

SIR,

I HAVE but very lately received your last obliging letter, of the 5th of July, with the volume of Philosophical Transactions.

I must beg of you to express my satisfaction at the notice which the Royal Society hath been pleased to take of my accounts of the two last eruptions of Mount Vesuvius. Since I have been at my villa here, I have enquired of the inhabitants of the mountain, after what they had seen during the last eruption. In my letter to Lord Morton, I mentioned nothing but what came immediately under my own observation.

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observation: but as all the peasants here agree in their account of the terrible thunder and lightning, which lasted almost the whole time of the eruption, upon the mountain only: I think it a circumstance worth attending to. Besides the lightning, which perfectly resembled the common forked lightning, there were many meteors, like what are vulgarly called falling stars. A peasant, in my neighbourhood, lost eight hogs, by the ashes falling into the trough with their food: they grew giddy, and died in a few hours. The last day of the eruption, the ashes, which fell abundantly upon the mountain, were as white almost as snow [o]s, and the old people here assure

[o] In some accounts of the eruption of Vesuvius in 1660, I find mention made of ashes which fell in the shape of crosses, and were looked upon as highly miraculous; but in one book upon this subject, intituled, *Athangii Kircheri Soc. Jes. De prodigiis crucibus, &c. Rome, MDCLXI.*, a very philosophical account is given of this phenomenon; he says, that, in 1660, from the 26th of August to the 15th of October, Vesuvius cast up ashes impregnated with nitrous, saline, and bitumine,

the; that is a sure symptom of the eruption being at an end. These circumstances being well attested, I thought worth relating.

It would require many years close application, to give a proper and truly philosophical account of the Volcanos in the neighbourhood of Naples; but I am sure such a history might be given, supported by demonstration, as would destroy every system hitherto given upon this subject. We have here an opportunity of seeing Volcanos in all their states. I have been this summer in the island of Ischia; it is about eighteen miles round, and its whole basis is lava. The great mountain in it, near as high as Vesuvius, formerly called Ercomeus, and now San Nicola, I am con-

vinced,

minous sulphur, which upon linen garments took the form of crosses, probably directed by the cross-threads in the linen, and therefore that the salts did not shoot into such a shape when they fell upon garments of woollen; a very particular description of these crosses may be found in page 38, of the abovementioned book.

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vinced, was thrown up by degrees; and I have no doubt in my own mind, but that the island itself rose out of the sea in the same manner as some of the Azores. I am of the same opinion with respect to Mount Vesuvius, and all the high grounds near Naples; as having not yet seen, in any one place, what can be called virgin earth. I had the pleasure of seeing a well sunk, a few days ago, near my villa, which is, as you know, at the foot of Vesuvius, and close by the sea-side. At twenty-five feet below the level of the sea, they came to a stratum of lava, and God knows how much deeper they might have still found other lavas. The soil all round the mountain, which is so fertile, consists of stratas of lavas, ashes, pumice, and now-and-then a thin stratum of good earth, which good earth is produced by the surface moulder-ing, and the rotting of the roots of plants, vines, &c. This is plainly to be seen at Pompeii, where they are now digging into the ruins of that ancient city; the houses are

are covered about ten or fifteen feet, with pumice and fragments of lava, some of which weigh three pounds (which last circumstance I mention, to shew, that, in a great eruption, Vesuvius has thrown stones of this weight six miles [*p*], which is its distance from Pompeii, in a direct line); upon this stratum of pumice, or *rapilli*, as they call them here, is a stratum of

[*p*] I have since found in this stratum of erupted matter at Pompeii, stones weighing eight pounds: but many accounts of the great eruption of Vesuvius, particularly that of Antonio Bulifon, mention that a stone like a bomb was thrown from the crater of Vesuvius in 1631, and fell upon the Marquis of Lauro's house at Nola, which it set on fire. As Nola is twelve miles from Vesuvius, this circumstance seems rather extraordinary: however, I have seen stones of an enormous size shot up to a very great height by Mount Vesuvius. In May 1771, having a stop watch in my hand, I observed that one of these stones was eleven seconds falling from its greatest height, into the crater from whence it had been ejected. In 1767, a solid stone, measuring twelve feet in height, and forty-five in circumference, was thrown a quarter of a mile from the crater; the eruption of 1767, though by much the most violent of this century, was, comparatively to those of the year 79 and 1631, very mild.

E

excellent

excellent mould, about two feet thick, on which grow large trees, and excellent grapes. We have then the Solfaterra, which was certainly a Volcano, and has ceased erupting, for want of metallic particles, and over-abounding with sulphur. You may trace its lavas into the sea. We have the Lago d'Averno and the Lago d'Agnano, both of which were formerly Volcanos; and Astroni, which still retains its form more than any of these. Its crater is walled round, and his Sicilian Majesty takes the diversion of boar-hunting in this Volcano; and neither his Majesty nor any one of his Court ever dreamt of its former state. We have then that curious mountain, called Montagno Nuovo, near Puzzole, which rose, in one night, out of the Lucrine Lake; it is about a hundred and fifty feet high, and three miles round. I do not think it more extraordinary, that Mount Vesuvius, in many ages, should rise above two thousand feet; when this mountain, as is well attested,

MOUNT VESUVIUS, &c. 51

not in one night, no longer ago than the year 1538., I have a project, next spring, of passing some days at Puzzole, and of dissecting this mountain, taking its measures, and making drawings of its stratas; for, I perceive, it is composed of stratas, like Mount Vesuvius, but without lavas. As this mountain is so undoubtedly formed entirely from a plain, I should think my project may give light into the formation of many other mountains, that are at present thought to have been original, and are certainly not so, if their strata correspond with those of the Montagno Nuovo. I should be glad to know whether you think this project of mine will be useful; and, if you do, the result of my observations may be the subject of another letter [q].

I cannot have a greater pleasure than to employ my leisure hours in what may be of some little use to mankind; and my

[q] See Letter V. in this collection.

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lot has carried me into a country, which affords an ample field for observation. Upon the whole, if I was to establish a system, it would be, that *Mountains are produced by Volcanos, and not Volcanos by Mountains.*

I fear I have tired you; but the subject of Volcanos is so favourite a one with me, that it has led me on I know not how: I shall only add, that Vesuvius is quiet at present, though very hot at top, where there is a deposition of boiling sulphur. The lava that ran in the Fossa Grande during the last eruption, and is at least two hundred feet thick, is not yet cool; a stick, put into its crevices, takes fire immediately. On the sides of the crevices are fine crystalline salts: as they are the pure salts, which exhale from the lava that has no communication with the interior of the mountain, they may perhaps indicate the composition of the lava.

I have done. Let me only thank you for the kind offers and expressions in your letter,

MOUNT VESUVIUS, &c. 53

letter, and for the care you have had in setting off my present to the Museum to the best advantage; of which I have been told from many quarters.

I am,

SIR,

Your most obedient

humble servant,

W. HAMILTON.



E 3

L E T-

LETTER IV,

To MATHEW MATY, M. D. Secretary to
the Royal Society.

An Account of a Journey to
MOUNT ETNA.

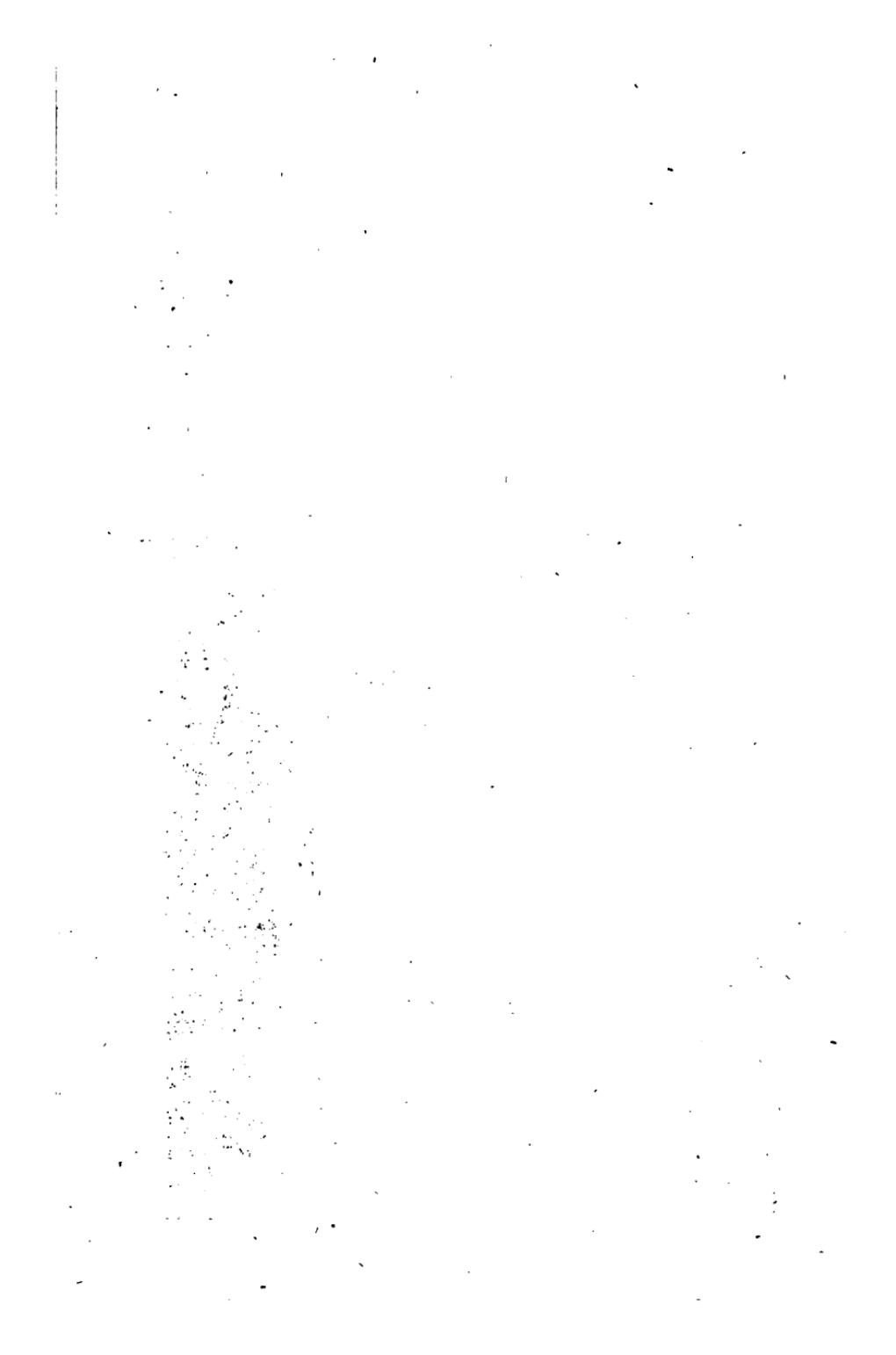
"Artificis natura ingens opus aspice, nulla
tu tanta humana rebus spectacula cernes."

P. CORNELII SEVERI *Etna*.

SIR,

Naples, Oct. 17, 1769.

ENCOURAGED by the assurances
you give me, in your last obliging
letter of the 15th of June, that any new
communication upon the subject of Vol-
cano's would be received with satisfaction
by the Royal Society; I venture to send
you the following account of my late ob-
servations upon Mount Etna, which you



A View of MOUNT AETNA from Taormina.



are at liberty to lay before our respectable Society, should you think it worth its notice. [See Plate IV.]

After having examined with much attention the operations of Mount Vesuvius, during the five years that I have had the honour of residing as his Majesty's Minister at this Court, and after having carefully remarked the nature of the soil for fifteen miles round this capital; I am, in my own mind, well convinced that the whole of it has been formed by explosion. Many of the craters, from whence this matter has issued, are still visible; such as the Solfaterra near Puzzole, the lake of Agnano, and near this lake a mountain composed of burnt matter, that has a very large crater surrounded with a wall, to inclose the wild boars and deer, that are kept there for the diversion of his Sicilian Majesty; it is called Afruni: the Monte Nuovo, thrown up from the bottom of the Lucrine lake [r] in the year 1538.

[r] It is the common received opinion, that this mountain rose from the bottom of the Lucrine lake. I

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which has likewise its crater, and the lake of Averno. The islands of Nisida and Procida are entirely composed of burnt matter; the island of Ischia is likewise composed of lava, pumice, and burnt matter; and there are in that island several visible craters, from one of which, no longer ago than the year 1303, there issued a lava, which ran into the sea, and is still in the same barren state as the modern lava of Vesuvius. After having, I say, been accustomed to these observations, I was well prepared to visit the most ancient, and perhaps the most considerable, Volcano that exists; and I had the satisfaction of being thoroughly convinced there, of the formation of very considerable mountains by meer explosion, having seen many such on the sides of Etna, as will be related hereafter,

had not seen the very curious and particular account of its formation (which account is in my next letter) when I wrote this, and was therefore in the same error.

On

On the 24th of June last, in the afternoon, I left Catania, a town situated at the foot of Mount Etna, or, as it is now called, Mon-Gibello, in company with Lord Fortrose and the Canonico Recupero, an ingenious priest of Catania, who is the only person there that is acquainted with the mountain : he is actually employed in writing its natural history ; but, I fear, will not be able to compass so great and useful an undertaking, for want of proper encouragement,

We passed through the inferior district of the mountain called by its inhabitants La Regione Piemontese. It is well watered, exceedingly fertile, and abounding with vines and other fruit trees, where the lava, or, as it is called there, the *sciara*, has had time to soften, and gather soil sufficient for vegetation, which, I am convinced from many observations, unless assisted by art, does not come to pass for many ages [s], perhaps a thousand years

[s] This must depend greatly upon the quality of the lava's ; some have been in a more perfect state of vitrification than others.

or more; the circuit of this lower region, forming the basis of the great Volcano, is upwards of one hundred Italian miles. The vines of Etna are kept low, quite the reverse of those on the borders of Vesuvius; and they produce a stronger wine, but not in so great abundance. The Piemontese district is covered with towns, villages, monasteries, &c. and is well peopled, notwithstanding the danger of such a situation. Catania, so often destroyed by eruptions of Etna, and totally overthrown by an earthquake towards the end of the last century, has been less liable to depopulation than others, and are consequently less liable to the impressions of time. I have often observed on Mount Vesuvius, when I have been close to the mouth from whence lava was discharging itself, that the quality of it varied greatly from time to time: I have seen it as fluid and coherent as glass when in fusion; and I have seen it十分acious, the particles separating as they forced their way out, just like meal coming from under the grindstones. A stream of lava of this sort, being less compact, and containing more earthy particles, would certainly be much sooner fit for vegetation, than one composed of the more perfect vitrified matter.

of the last century [2], has been re-built within those fifty years, and is now a considerable town, with at least thirty-five thousand inhabitants. I do not wonder at the seeming security with which these parts are inhabited; having been so long witness to the same near Mount Vesuvius! The operations of Nature are slow; great eruptions do not frequently happen; each ravages himself; it will not happen in this time, or, if it should, that His celestial Saint will turn away the destructive lava from his grounds; and indeed the great fertility in the neighbourhoods of Volcanos tempts people to inhabit them.

In about four hours of gradual ascent, we arrived at a little convent of Benedictine monks, called St. Nicolo dell' Arena, about thirteen miles from Cata-

[2] This earthquake happened in the year 1693, and destroyed forty-nine towns and villages, nine hundred and twenty-two churches, colleges, and convents; and near one hundred thousand persons were buried in their ruins,

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nia, and within a mile of the Volcano from whence issued the last very great eruption in the year 1669; a circumstantial account of which was sent to our court by a Lord Winchelsea, who happened to be then at Catania in his way home, from his embassy at Constantinople. His Lordship's account is curious, and was printed in London soon after; I saw a copy of it at Palermo, in the library of the Prince Torremuzzo [u]. We slept

[u] It is intituled, "A true and exact relation of the late prodigious earthquake and eruption of Mount Ætna, or Monte Gibello; as it came in a letter written to his Majesty from Naples, by the Right Honourable the Earl of Winchelsea, his Majesty's late Ambassador at Constantinople, who, in his return from thence, visiting Catania in the island of Sicily, was an eye-witness of that dreadful spectacle; together with a more particular narrative of the same, as it is collected out of the several relations sent from Catania; published by authority. Printed by T. Newcomb, in the Savoy, 1669."

" I accepted, says the author, p. 38, the invitation of the Bishop of Catania, to stay a day with him, that so I might be the better able to inform your Majesty

in the Benedictines convent the night of
the 24th, and passed the next morning in.

“ of that extraordinary fire, which comes from Mount
“ Gibel, fifteen miles distant from that city, which, for
“ its horridness in the aspect, for the vast quantity
“ thereof (for it is fifteen miles in length, and seven in
“ breadth), for its monstrous devastation and quick
“ progress, may be termed an inundation of fire, a
“ flood of fire, cinders, and burning stones, burning
“ with that rage as to advance into the sea six hundred
“ yards, and that to a mile in breadth, which I saw ;
“ and that which did augment my admiration was, to
“ see in the sea this matter like ragged rocks, burning
“ in four fathom water, two fathom higher than the
“ sea itself, some parts liquid, and throwing off, not
“ with great violence, the stones about it, which, like a
“ crust of a vast bigness, and red hot, fell into the sea
“ every moment, in some place or other, causing a great
“ and horrible noise, smoak, and hissing in the sea ;
“ and that more and more coming after it, making a
“ firm foundation in the sea itself. I stayed there from
“ nine a clock on Saturday mornng, to seven next
“ morning ;” (this must have been towards the middle
or latter end of April;) “ and this mountaint of fire
“ and stones with cinders had advanced into the sea
“ twenty yards at least, in several places; in the mid-
“ dle of this fire, which burnt in the sea, it hath form-
“ ed like to a river, with its banks on each side very
“ steep and craggy; and in this channel moves the
observing

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observing the ravage made by the above-mentioned terrible eruption, over the rich

" greatest quantity of this fire, which is the most liquid;
" with stones of the same composition, and cinders all
" red hot, swimming upon the fire of a great magni-
" tude; from this a river of fire doth proceed under the
" great mass of the stones, which are generally three
" fathoms high all over the country, where it burns,
" and in other places much more. These are secret
" conduits or rivulets of this liquid matter, which com-
" municates fire and heat into all parts more or less,
" and melts the stones and cinders by ~~fire~~ in those places
" where it toucheth them, over and over again; where
" it meets with rocks or houses of the same matter (as
" many are), they melt and go away with the fire;
" where they find other compositions, they turn them
" to lime or ashes (as I am informed). The compo-
" sition of this fire, stones, and cinders, are sulphur,
" nitre, quicksilver, sal ammoniac, lead, iron, brads, and
" all other metals. It moves not regularly, nor con-
" stantly down hill *; in some places it hath made the

* Having heard the same remark with respect to the lava's of Vesuvius, I determined, during an eruption of that Volcano, to watch the progress of a current of lava, and I was soon enabled to comprehend this seeming phenomenon; though it is, I fear, very difficult to explain. Certain it is, that the lava's, whilst in their most fluid state, follow always the law of other fluids; but when at a great distance from their source, and consequently encumbered with scoria and cinders, the air likewise having rendered their outward coat tough, they will sometimes (as I have

COUNTRY

country of the Piemontese. The lava burst out of a vineyard within a mile of

" vallies hills, and the hills that are not high are now
 " vallies. When it was night, I went upon two
 " towers, in divers places ; and could plainly see at ten
 " miles distance, as we judged, the fire to begin to run
 " from the mountain in a direct line, the flame to ascend
 " as high and as big as one of the greatest steeples in
 " your Majesty's Kingdoms, and to throw up great stones
 " into the air ; I could discern the river of fire to de-
 " scend the mountain of a terrible fiery or red colour,
 " and stones of a paler red to swim thereon, and to be
 " some as big as an ordinary table. We could see this
 " fire to move in several other places, and all the country
 " covered with fire, ascending with great flames †, in
 " many places, smoaking like to a violent furnace of

seen) be forced up a short ascent, the fresh matter pushing forward that which went before it, and the exterior parts of the lava acting always as conductors (or pipes, if I may be allowed the expression), for the interior parts, that have retained their fluidity by not having been exposed to the air.

† The flames Lord Winchelsea mentions, were certainly produced by the lava having met with trees in its way ; or perhaps his Lordship may have mistaken the white smoke which constantly rises from a lava (and in the night is tinged by the reflection of the red hot matter), for flame, of which indeed it has greatly the appearance at a distance. I have observed upon Mount Vesuvius, that, soon after a lava has borne down and burned a tree, a bright flame issues from its surface ; otherwise I have never seen any flame attending an eruption.

St.

64 OBSERVATIONS ON

St. Nicolo, and, by frequent explosions of stones and ashes, raised there a mountain, which, as near as I can judge, having ascended it, is not less than half a mile

" iron melted, making a noise with the great pieces
" that fell, especially those which fell into the sea. A
" Cavalier of Malta, who lives there, and attended me,
" told me, that the river was as liquid where it issues
" out of the mountain, as water, and came out like a
" torrent with great violence, and is five or six fathom
" deep, and as broad, and that no stones sink therein.
" I assure your Majesty, no pen can express how terrible it is, nor can all the art and industry of the world
" quench or divert that which is burning in the country. In forty days time, it hath destroyed the habitations of 27,000 persons; made two hills of one, 1000 paces high apiece, and one is four miles in compass; of 20,000 persons, which inhabit Catania, 3000 did only remain; all their goods are carried away, the cannons of brass are removed out of the castle, some great bells taken down, the city-gates walled up next the fire, and preparations made to abandon the city.

" That night which I lay there, it rained ashes all over the city, and ten miles at sea it troubled my eyes. This fire in its progress met with a lake of four miles in compass; and it was not only satisfied to fill it up, though it was four fathom deep, but hath made of it a mountain."

perpen-

perpendicular in height, and is certainly at least three miles in circumference at its basis. The lava that ran from it, and on which there are as yet no signs of vegetation, is fourteen miles in length, and in many parts six in breadth; it reached Catania, and destroyed part of its walls, buried an amphitheatre, an aqueduct, and many other monuments of its ancient grandeur, which till then had resisted the hand of Time, and ran a considerable length into the sea, so as to have once formed a beautiful and safe harbour; but it was soon after filled up by a fresh torrent of the same inflamed matter: a circumstance the Catanians lament to this day, as they are without a port. There has been no such eruption since; though there are signs of many, more terrible, that have preceded it.

For two or three miles round the mountain raised by this eruption, all is barren, and covered with ashes; this ground, as well as the mountain itself, will in time

F certainly

66 OBSERVATIONS ON

certainly be as fertile as many other mountains in its neighbourhood, that have been likewise formed by explosion. If the dates of these explosions could be ascertained, it would be very curious, and mark the progress of time with respect to the return of vegetation, as the mountains raised by them are in different states; those which I imagine to be the most modern are covered with ashes only; others of an older date, with small plants and herbs; and the most ancient, with the largest timber-trees I ever saw: but I believe the latter are so very ancient, as to be far out of the reach of history. At the foot of the mountain, raised by the eruption of the year 1669, there is a hole, through which, by means of a rope, we descended into several subterraneous caverns, branching out and extending much farther and deeper than we chose to venture; the cold there being excessive, and a violent wind frequently extinguishing some of our torches. These caverns undoubt-

undoubtedly contained the lava that issued forth, and extended, as I said before, quite to Catania. There are many of these subterraneous cavities known, on other parts of Etna; such as that called by the peasants La Baracca Vecchia, another La Spelonca della Palomba (from the wild pigeons building their nests therein), and the cavern Thalia, mentioned by Boccaccio. Some of them are made use of as magazines for snow; the whole island of Sicily and Malta being supplied with this essential article (in a hot climate) from Mount Etna. Many more would be found, I dare say, if searched for, particularly near and under the craters from whence great lavas have issued, as the immense quantities of such matter we see above ground must necessarily suppose very great hollows underneath.

After having passed the morning of the 25th in these observations, we proceeded through the second or middle region of

F 2 Etna,

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Etna, called La Selvosa, *the woody*, than which nothing can be more beautiful. On every side are mountains, or fragments of mountains, that have been thrown up by various ancient explosions; there are some near as high as Mount Vesuvius; one in particular (as the Canon our guide assured me, having measured it) is little less than one mile in perpendicular height, and five in circumference at its basis. They are all more or less covered, even within their craters, as well as the rich vallies between them, with the largest oak, chesnut, and firr trees, I ever saw any where; and indeed it is from hence chiefly, that his Sicilian Majesty's dock-yards are supplied with timber. As this part of Etna was famous for its timber in the time of the Tyrants of Syracusa, and as it requires the great length of time I have already mentioned before the matter is fit for vegetation, we may conceive the great age of this respectable Volcano. The chesnut-trees predominated in the

parts through which we passed, and, though of a very great size, are not to be compared to some on another part of the Regione Selvosa, called Carpinetto. I have been told by many, and particularly by our guide, who had measured the largest there, called La Castagna di Cento Cavalli, that it is upwards of twenty-eight Neapolitan canes in circumference. Now as a Neapolitan cane is two yards and half a quarter, English measure, you may judge, Sir, of the immense size of this famous tree [x]. It is hollow from age, but there is another near it almost as large and sound. As it would have required a journey of two days to have visited this extraordinary tree, and the weather being already very hot, I did not see it. It is

[x] I have heard since, from some of our countrymen who have measured this tree, that its dimensions are actually as abovementioned; but that they could perceive some signs of four stems having grown together, and formed one tree.

amazing to me, that trees should flourish in so shallow a soil; for they cannot penetrate deep without meeting with a rock of lava; and indeed great part of the roots of the large trees we passed by are above ground, and have acquired, by the impression of the air, a bark like that of their branches. In this part of the mountain, are the finest horned cattle in Sicily; we remarked in general, that the horns of the Sicilian cattle are near twice the size of any we had ever seen; the cattle themselves are of the common size. We passed by the lava of the last eruption in the year 1766, which has destroyed above four miles square of the beautiful wood abovementioned. The mountain raised by this eruption abounds with sulphur and salts, exactly resembling those of Vesuvius; specimens of which I sent some time ago to the late Lord Morton.

In about five hours from the time we had left the convent of St. Nicolo dell'

Arena,

Arena, we arrived at the borders of the third region, called La Netta, or Scoperta, *clean or uncovered*, where we found a very sharp air indeed; so that, in the same day, the four seasons of the year were sensibly felt by us, on this mountain; excessive summer heats in the Piemontese, spring and autumn temperature in the middle, and extreme cold of winter in the upper region. I could perceive, as we approached the latter, a gradual decrease of vegetation; and from large timber trees we came to the small shrubs and plants of the northern climates: I observed quantities of juniper and tanzey; our guide told us, that later in the season there are numberless curious plants here, and that in some parts there are rhubarb and saffron in plenty. In Carrera's History of Catania, there is a list of all the plants and herbs of Etna, in alphabetical order.

Night coming on, we here pitched a tent, and made a good fire, which was very necessary; for without it, and very warm

F 4 cloathing,

cloathing, we should surely have perished with cold; and at one of the clock in the morning of the 26th, we pursued our journey towards the great crater. We passed over vallies of snow, that never melts, except there is an eruption of lava from the upper crater, which scarcely ever happens; the great eruptions are usually from the middle region, the inflamed matter finding (as I suppose) its passage through some weak part, long before it can rise to the excessive height of the upper region, the great mouth on the summit only serving as a common chimney to the Volcano. In many places the snow is covered with a bed of ashes, thrown out of the crater, and the sun melting it in some parts makes this ground treacherous; but as we had with us, besides our guide, a peasant well accustomed to these vallies, we arrived safe at the foot of the little mountain of ashes that crowns Etna, about an hour before the rising of the sun. This mountain is situated in a gently inclining

clining plain, of about nine miles in circumference; it is about a quarter of a mile perpendicular in height, very steep, but not quite so steep as Vesuvius; it has been thrown up within these twenty-five or thirty years, as many people at Catania have told me they remembered when there was only a large chasm or crater, in the midst of the abovementioned plain. Till now, the ascent had been so gradual (for the top of Etna is not less than thirty miles from Catania, from whence the ascent begins) as not to have been the least fatiguing; and if it had not been for the snow, we might have rode upon our mules to the very foot of the little mountain, higher than which the Canon our guide had never been: but as I saw that this little mountain was composed in the same manner as the top of Vesuvius, which, notwithstanding the smoak issuing from every pore, is solid and firm, I made no scruple of going up to the edge of the crater; and my companions followed. The steep

steep ascent, the keenness of the air, the vapours of the sulphur, and the violence of the wind, which obliged us several times to throw ourselves flat upon our faces to avoid being overturned by it, made this latter part of our expedition rather inconvenient and disagreeable. Our guide, by way of comfort, assured us, that there was generally much more wind in the upper region at this time.

Soon after we had feated ourselves on the highest point of Etna, the sun arose, and displayed a scene that indeed passes all description. The horizon lighting up by degrees, we discovered the greatest part of Calabria, and the sea on the other side of it; the Phare of Messina, the Lipari Islands; Stromboli, with its smoaking top, though at above seventy miles distance, seemed to be just under our feet; we saw the whole island of Sicily, its rivers, towns, harbours, &c. as if we had been looking on a map. The island of Malta is low ground, and there was a haziness

in

in that part of the horizon, so that we could not discern it; our guide assured us, he had seen it distinctly at other times, which I can believe, as in other parts of the horizon, that were not hazy, we saw to a much greater distance; besides, we had a clear view of Etna's top from our ship, as we were going into the mouth of the harbour of Malta some weeks before; in short, as I have since measured on a good chart, we took in at one view a circle of above nine hundred English miles. The pyramidal shadow of the mountain reached across the whole island, and far into the sea on the other side. I counted from hence forty-four little mountains (little I call them in comparison of their mother Etna, though they would appear great any where else) in the middle region on the Catania side, and many others on the other side of the mountain, all of a conical form, and each having its crater; many with timber trees flourishing both within and without their craters.

The

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The points of those mountains that I imagine to be the most ancient are blunted, and the craters of course more extensive and less deep than those of the mountains formed by explosions of a later date, and which preserve their pyramidal form entire. Some have been so far mouldered down by time, as to have no other appearance of a crater than a sort of dimple or hollow on their rounded tops, others with only half or a third part of their cone standing; the parts that are wanting having mouldered down, or perhaps been detached from them by earthquakes, which are here very frequent. All however have been evidently raised by explosion; and I believe, upon examination, many of the whimsical shapes of mountains in other parts of the world would prove to have been occasioned by the same natural operations. I observed that these mountains were generally in lines or ridges; they have mostly a fracture on one side, the same as in the little mountains

mountains raised by explosion on the sides of Vesuvius, of which there are eight or nine. This fracture is occasioned by the lava's forcing its way out, which operation I have described in my account of the last eruption of Vesuvius. Whenever I shall meet with a mountain, in any part of the world, whose form is regularly conical, with a hollow crater on its top, and one side broken, I shall be apt to decide such a mountain's having been formed by an eruption; as both on Etna and Vesuvius the mountains formed by explosion are without exception according to this description. But to return to my narrative.

After having feasted our eyes with the glorious prospect above-mentioned (for which, as Spartian tells us, the Emperor Adrian was at the trouble of ascending Etna), we looked into the great crater, which, as near as we could judge, is about two miles and a half in circumference; we did not think it safe to go round and measure

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measure it, as some parts seemed to be very tender ground. The inside of the crater, which is incrusted with salts and sulphurs like that of Vesuvius, is in the form of an inverted hollow cone, and its depth nearly answers to the height of the little mountain that crowns the great Volcano. The smoak, issuing abundantly from the sides and bottom, prevented our seeing quite down; but the wind clearing away the smoak from time to time, I saw this inverted cone contracted almost to a point; and, from repeated observations, I dare say, that in all Volcanos, the depth of the craters will be found to correspond nearly to the height of the conical mountains of cinders which usually crown them: in short, I look upon the craters as a sort of suspended funnels, under which are vast caverns and abysses. The formation of such conical mountains with their craters are easily accounted for, by the fall of the stones, cinders, and ashes, emitted at the time of an eruption.

The smoak of Etna, though very sulphureous, did not appear to me so fetid and disagreeable as that of Vesuvius; but our guide told me, that its quality varies, as I know that of Vesuvius does, according to the quality of the matter then in motion within. The air was so very pure and keen in the whole upper region of Etna, and particularly in the most elevated parts of it, that we had a difficulty in respiration, and that, independent of the sulphureous vapour. I brought two barometers and a thermometer with me from Naples, intending to have left one with a person at the foot of the mountain, whilst we made our observation with the other, at sun-rising, on the summit; but one barometer was unluckily spoilt at sea, and I could find no one expert enough at Catania to repair it: what is extraordinary, I do not recollect having seen a barometer in any part of Sicily. At the foot of Etna, the 24th, when we made our first observation, the quicksilver stood

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stood at 27 degrees of lines; and the 26th, at the most elevated point of the Volcano, it was at 18 degrees 10 lines. The thermometer, on the first observation at the foot of the mountain was at 84 degrees, and on the second at the crater at 56.^[y]. The weather had not changed

[y] No great stress should be laid upon these observations, as the many inconveniences we laboured under, and the little practice we had in such nice operations, must necessarily have rendered them very inaccurate. The Canon Recupero, who was our guide, attended Messrs. Glover, Fullerton, and Brydone, up Mount Etna in June 1770. The latter is a very ingenious and accurate observer, and has taken the height of many of the highest mountains in the Alps. His observations, as the Canon informed me, were as follows: At the top of the mountain the quicksilver in the thermometer was 9 degrees below freezing point, when at the foot of the mountain it rose to 76. At the foot of the little mountain that crowns the Volcano the barometer stood at 20° 4 $\frac{2}{3}$ ', half way up this little mountain it was at 19° 6'; but the wind was too violent for them to attempt any more observations. The barometer and thermometer were of Fahrenheit's. Mr. Brydone remarked, as he went up in the night, that he could distinguish the stars in the milky way with won-

MOUNT VESUVIUS, &c. 81

in any respect, and was equally fine and clear, the 24th and 26th. We found it difficult to manage our barometer in the extreme cold and high wind on the top of Etna; but from the most exact observations we could make in our circumstances, the result was as abovementioned. The Canon assured me, that the perpendicular height of Mount Etna is something more than three Italian miles, and I verily believe it is so.

After having passed at least three hours on the crater, we descended, and went to a rising ground, about a mile distant from the upper mountain we had just left, and saw there some remains of the foundation of an ancient building; it is of brick, and seems to have been ornamented with white marble, many fragments of which are scattered about. It is called the Philosopher's Tower, and is said to have been

derful clearness, and that the cold was much more intense than he had ever felt upon the highest mountains of the Alps.

G

inhabited

inhabited by Empedocles. As the ancients used to sacrifice to the celestial gods on the top of Etna [z], it may very well be the ruin of a temple that served for that purpose. From hence we went a little further over the inclined plain abovementioned, and saw the evident marks of a dreadful torrent of hot water, that came out of the great crater at the time of an eruption of lava in the year 1756, and upon which phenomenon the Canganico Recupero; our guide, has published a dissertation. Luckily this torrent did not take its course over the inhabited parts of the mountain; as a like accident on Mount Vesuvius in 1631 swept away some towns and villages in its neighbourhood, with thousands of their inhabitants. The

[z]. This passage, in Cornificius Severus's poem upon Etna, seems to confirm my opinion:

"Placantesque etiam cœlestia numina thure"

"Summo cerne jugo, vel quâ liberrimus Etna"

"Improspectus hinc; tantum semina rerum regis"

"Si nihil irritet flamas, stipetque profundum."

common

common received opinion is, that these eruptions of water proceed from the Volcanos having a communication with the sea; but I rather believe them to proceed merely from depositions of rain water in some of the inward cavities of them. We likewise saw from hence the whole course of an ancient lava, the most considerable as to its extent of any known here, it ran into the sea near Taormina, which is not less than thirty miles from the crater whence it issued, and is in many parts fifteen miles in breadth. As the lavas of Etna are very commonly fifteen and twenty miles in length, six or seven in breadth, and fifty feet, or more in depth; you may judge, Sir, of the prodigious quantities of matter emitted in a great eruption of this mountain, and of the vast cavities there must necessarily be within its bowels. The most extensive lavas of Veluvius do not exceed seven miles in length. The operations of nature on the one mountain and the other are certainly the same;

but

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but on Mount Etna, all are upon a great scale. As to the nature and quality of their lavas, they are much the same; but I think those of Etna rather blacker, and in general more porous, than those of Vesuvius. In the parts of Etna that we went over, I saw no stratas of pumice stones, which are frequent near Vesuvius, and cover the ancient city of Pompeii; but our guide told us, that there are such in other parts of the mountain. I saw some stratas of what is called here *tufa*; it is the same that covers Herculaneum, and that composes most of the high grounds about Naples; it is, upon examination, a mixture of small pumice stones, ashes, and fragments of lava, which is by time hardened into a sort of stone [a]. In short, I found, with respect to the matter erupted, nothing on Mount Etna that Vesuvius does not produce; and there certainly is a much greater variety in the

[a] A better account of the formation of *tufa* will be seen in my next letter.

erupted matter and lavas of the latter, than of the former; both abound with pyrites and crystallizations, or rather vitrifications. The sea shore at the foot of Etna, indeed, abounds with amber, of which there is none found at the foot of Vesuvius. At present there is a much greater quantity of sulphur and salts on the top of Vesuvius than on that of Etna; but this circumstance varies according to the degree of fermentation within; and our guide assured me, he had seen greater quantities on Etna at other times. In our way back to Catania, the Canon shewed me a little hill, covered with vines, which belonged to the Jesuits, and, as is well attested, was undermined by the lava in the year 1669; and transported half a mile from the place where it stood, without having damaged the vines.

In great eruptions of Etna, the same bolt of lightning, as described in my account of the last eruption of Vesuvius, has been frequently seen to issue from

the smoke of its great crater. The ancients took notice of the same phenomenon; for Seneca (lib. ii. Nat. Quæst.) says,—
“Ætna aliquando multo igne abundavit,
“ingentem vim arenæ ureatis effudit, in,
“voluptus est dies pulvere, populosque
“sybita nox terruit, illo tempore autem plus
“rima fuisse tonitrua et fulmina.”

Till the year 352 of Christ, the chronological accountings of the eruptions of Etna are very imperfect; but as the veil of St. Agatha was laid that year first opposed to check the violence of the torrents of lava, and has ever since been produced at the time of great eruptions, the miracles attributed to its influence, having been carefully recorded by the priests, have at least preserved the dates of such eruptions. The reliks of St. Januarius have rendered the same service to the lovers of natural history, by recording the great eruptions of Vesuvius. I find, by the dates of the eruptions of Etna, that it is as irregular as most things of this kind and

and uncertain in its operations as Vesuvius [6]. The last eruption was in 1766.

On our return from Messina to Naples, we were becalmed three days in the midst of the Lipari islands, by which we had an opportunity of seeing that they have all been evidently formed by explosion [c];

{b} The dates of the eruptions of Mount Etna, recorded by history, are as follow: Before the Christian era, four, in the years 3545, 3238, 3534, 3843. After Christ, twenty-seven have been recorded, 1175, 1285, 1321, 1323, 1329, 1408, 1530, 1536, 1537, 1540, 1545, 1554, 1556, 1566, 1579, 1641, 1634, 1636, 1643, 1669, 1682, 1689, 1692, 1702, 1747, 1755,

Play, conclude account of these islands, in the
xx chapter of the third book of his Natural History,
seems to confirm this opinion.

Lipara cùm **clivis** **Romanorum** - oppido, dicta à
Lipara rege, qui successit **Æolo**, antea **Meliganis** vel
Meliganis vocitata, abest xii milia pass. ab Italia,

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one of them, called Vulcano, is in the same state as the Solfaterra. Stromboli is a Volcano, existing in all its force, and, in its form of course, is the most pyramidal of all the Lipari Islands; we saw it throw up red hot stones from its crater frequently, and some small streams of lava issued from its side, and ran into the sea [d]. This Volcano differs from Etna and Vesuvius, by its continually emitting fire, and seldom any lava; notwithstanding its continual explosions, this island is inhabited, on one side, by about an hundred families.

" ipsa circuitu paulo minori. Inter hanc et Siciliam
 " altera, antea Therasia appellata, nunc Hieri; qui
 " sacra Vulcano est, colle in ea nocturnas evomentes
 " flammam, Tertia Strongyle, a Lipara millia passuum
 " ad exortum solis vergens, in qua regnavit Eolo, quae
 " a Lipara liquidiore flamme tantum differit: e cuius
 " fumo equinam flaturi sint venti, in triduum praedicere
 " incipie traduntur; unde ventos Eolo paruisse existi-
 " timatum. Quarta Didyme, minor quam Lipara.
 " Quinta Ericusa; sexta Phoenicusa; paulo proxi-
 " morum relicta. Novissima, eademque Minima,
 " Erynnios."

[d] See Plate V.

These,

STROMBOLI, one of the LIPARI ISLANDS.



1. *Constitutive* *genes* - *Ideas* *involved* *in* *development* *of* *the* *organism*
2. *Regulatory* *genes* - *Genes* *involved* *in* *controlling* *the* *expression* *of* *constitutive* *genes*

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MORALITY AND THE STATE

MOUNT VESUVIUS, &c. 89

These, as well as I can recollect, are all the observations that I made with respect to Volcanos, in my late curious tour of Sicily; and I shall be very happy should the communication of them afford you, or any of our countrymen (lovers of natural history) satisfaction or entertainment.

I am,

Sir,

With great regard and esteem,

Your most obedient

humble servant,

W. HAMILTON.



L E T.

90 OBSERVATIONS ON

the following are I as full as short

and general view of Italy I have : which is
as follows: **LOCE: THE TUE: ROC: VIS:** blanch
and greenish, the country is very bad
To MATHEW MATY, MD. Secretary to
the Royal SOCIETY.

REMARKS upon the NATURE of the Soil
of NAPLES, and its Neighbourhood.

PLATE VI.

"Mille miracula movet faciemque mutar locis, et de-
"seruit moches; sublatisque vallis exuberat novas;
"in profundo insulas erigit."
inscribed from SENECA, De Terra-motu.

SIR,
Naples, Oct. 16, 1770.

ACCORDING to your desire, I lose
no time in sending you such further
remarks as I have been making with some
diligence, for six years past, in the compass
of twenty miles, or more, round this ca-
pital. By accompanying these remarks with
a map of the country I describe [PLATE VI.],
and

land with the specimens of different matter's that compose the most remarkable spots of it, I do not doubt but that I shall convince you, as I am myself convinced, that the whole circuit (so far as I have examined) within the boundaries marked in the map is wholly and totally the production of Subterraneous fires; and that most probably these fires formerly reached the mountains that lie behind Capua and Gaferta, and are a continuation of the Apennines. If I may be allowed to compare small things with great, I imagine the Subterraneous fires to have worked in this country, under the bottom of the sea, as moles in a field, throwing up here and there a hillock; and that the matter thrown out of some of these hillocks, forced into settled Volcanos, filling up the space between one and the other, has composed this part of the continent, and many of the islands adjoining; no other way to account for them.

From the observations I have made upon Mount Etna, Vesuvius, and its neighbourhood,

hood, I dare say, that, after a careful examination, most mountains, that are or have been Volcanos, would be found to owe their existence to subterraneous fire; the direct reverse of what I find the commonly received opinion.

Nature, though varied, is certainly in general uniform in her operations; and I cannot conceive that two such considerable Volcanos as Etna and Vesuvius should have been formed otherwise than every other considerable Volcano of the known world. I do not wonder that so little progress has been made in the improvement of natural history, and particularly in that branch of it which regards the theory of earth. Nature acts slowly; it is difficult to catch her in the fact. Those who have made this subject their study have, without scruple, undertaken at once, to write the natural history of a whole province, or of an entire continent; not reflecting, that the longest life of man affords but a very small portion of time for so slowly

scarcely affords him time to give a perfect one of the smallest insect.

I am sensible of what I undertake in giving you, Sir, even a very imperfect account of the nature of the soil of a little more than twenty miles round Naples: yet I flatter myself that my remarks, such as they are, may be of some use to any one hereafter, who may have leisure and inclination to follow them up. The kingdom of the Two Sicilies offers certainly the fairest field for observations of this kind, of any in the whole world; there are Volcanos existing in them still forte, some on their decline, and others actually extinct. To begin with some degree of order, which is really difficult in the variety of matter that occurs to my mind, I will first mention the basis on which I founded all my conjectures. It is the nature of the soil that covers the antient towns of Herculaneum and Pompeii, and the interior and exterior form of the new mountain,

near

near Puzzole, with the sort of materials of which it is composed. It cannot be denied, that Herculaneum and Pompeii stood once above ground; though now, the former is in no part less than seventy feet, and in some parts one hundred and twelve feet, below the present surface of the earth; and the latter is buried ten or twelve feet deep, more or less. As we know from the very accurate account given by Pliny, the younger to Tacitus, and from the accounts of other contemporary authors, that these towns were buried by an eruption of Mount Vesuvius in the time of Titus; it must be allowed, that whatever matter lies between these cities and the present surface of the earth over them, must have been produced since the year 79 of the Christian æra, the date of that formidable eruption.

Pompeii, which is situated at a much greater distance from the Volcano than Herculaneum, has felt the effects of a single eruption only; it is covered with white

white pumice stones, mixed with fragments of lava and burnt matter, large and small; the pumice is very light; but I have found some of the fragments of lava and cinders there, weighing eight pounds. I have often wondered, that such weighty bodies could have been carried to such a distance (for Pompeii cannot be less than five miles, in a strait line, from the mouth of Vesuvius). Every observation confirms the fall of this horrid shower over the unfortunate city of Pompeii, and that few of its inhabitants had dared to venture out of their houses; for in many of those which have been already cleared, skeletons have been found, some with gold rings, ear rings, and bracelets. I have been present at the discovery of several human skeletons myself; and under a vaulted arch, about two years ago, at Pompeii, I saw the bones of a man and a horse taken up, with the fragments of the horse's furniture, which had been ornamented with false teeth set in bronze. The skulls of some

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of the skeletons found in the streets had been evidently fractured by the fall of the stones. His Sicilian Majesty's excavations are confined to this spot at present; and the curious in antiquity may expect hereafter, from so rich a mine, ample matter for their dissertations: but I will confine myself to such observations only as relate to my present subject.

Over the stratum of pumice and burnt matter that covers Pompeii, there is a stratum of good mould, of the thickness of about two feet and more in some parts, in which vines flourish, except in some particular spots of this vineyard, where they are subject to be blasted by a foul vapour, or *mofete*, as it is called here, that rises from beneath the burnt matter. The abovementioned shower of pumice stones, according to my observations, extended beyond Castel-a-mare (near which spot the ancient town of Stabia also lies buried under them), and covered a tract of country not less than thirty miles in circumference.

It was at Stabia that Pliny the elder lost his life, and this shower of pumice stones is well described in the younger Pliny's letters. Little of the matter that has issued from Vesuvius since that time, has reached these parts: but I must observe, that the pavement of the streets of Pompeii is of lava; nay, under the foundation of the town, there is a deep stratum of lava and burnt matter. These circumstances, with many others that will be related hereafter, prove, beyond a doubt, that there have been eruptions of Vesuvius previous to that of the year 79, which is the first recorded by history.

The growth of soil by time is easily accounted for; and who, that has visited ruins of ancient edifices, has not often seen a flourishing shrub, in a good soil, upon the top of an old wall? I have remarked many such on the most considerable ruins at Pompeii and elsewhere. But from the soil which has grown over the barren pumice that covers Pompeii, I was enabled to make

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a curious observation. Upon examining the cuts and hollow ways made by currents of water in the neighbourhood of Vesuvius and of other Volcanos, I had remarked that there lay frequently a stratum of rich soil, of more or less depth, between the matter produced by the explosion of succeeding eruptions [e]; and I was naturally led to think, that such a stratum had grown in the same manner as the one abovementioned over the pumice of Pompeii. Where the stratum of good soil was thick, it was evident to me that many years had elapsed between one eruption and that which succeeded it. I do not pretend to say, that a just estimate can be formed of the great age of Volcanos from

[e] The Abate Giulio Cesare Bruccini describes very elegantly, in his account of the eruption of Vesuvius in 1631, his having made an observation of the like nature—his words are (after having particularized the different strata of erupted matter lying one over another)—“ parendo appunto che la natura ci abbia voluto lasciare scritto in questa terra tutti gli incendii memorabili raccontati degli autori.”

this

this observation; but some sort of calculation might be made: for instance, should an explosion of pumice cover again the spot under which Pompeii is buried, the stratum of rich soil abovementioned would certainly lie between two beds of pumice; and if a like accident had happened a thousand years ago, the stratum of rich soil would as certainly have wanted much of its present thickness, as the rotting of vegetables, manure, &c. is ever increasing a cultivated soil. Whenever I find then a succession of different strata of pumice and burnt matter, like that which covers Pompeii, intermixed with strata of rich soil, of greater or less depth, I hope I may be allowed reasonably to conclude, that the whole has been the production of a long series of eruptions, occasioned by subterraneous fire. By the size and weight of the pumice, and fragments of burnt erupted matter in these strata; it is easy to trace them up to their source, which I have done more than once in the neighbourhood.

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hood of Puzzole, where explosions have been frequent. The gradual decrease in the size and quantity of the erupted matter in the stratum abovementioned, from Pompeii to Castle a Mare, is very visible: at Pompeii, as I said before, I have found them of eight pounds weight, when at Castle-a-Mare the largest do not weigh an ounce.

The matter which covers the ancient town of Herculaneum is not the produce of one eruption only; for there are evident marks that the matter of six eruptions has taken its course over that which lies immediately above the town, and was the cause of its destruction. These strata are either of lava or burnt matter, with veins of good soil between them. The stratum of erupted matter that immediately covers the town, and with which the theatre and most of the houses were filled, is not of that foul vitrified matter, called lava, but of a sort of soft stone, composed of pumice, ashes, and burnt matter. It is exactly of the

the same nature with what is called here the Naples stone; the Italians distinguish it by the name of *tufa*, and it is in general use for building. Its colour is usually that of our free stone, but sometimes tinged with grey, green, and yellow; and the pumice stones, with which it ever abounds, are sometimes large, and sometimes small: it varies likewise in its degree of solidity.

The chief article in the composition of *tufa* seems to me to be, that fine burnt material, which is called *puzzolane*, whose binding quality and utility by way of cement are mentioned by Vitruvius [f], and

[f] These are his words, book II. chap. vi.

" De Pulvere Puteolano.

" Est etiam genus pulveris, quod efficit natulariter res admirandas. Nascitur in regionibus Baianis, " et in agris municipiorum, quae sunt circa Vesuvium montem, quod commixtum cum calce et cæmento non modo cæteris ædificiis prestat firmitates, sed etiam moles, quæ construuntur in mari, sub aqua solidescunt. Hoc autem fieri hac ratione videtur, quod sub his montibus et terra ferventes sunt fontes ærebri, qui non essent, si non in imo haberent, aut de sulfure, aut alumine, aut bitumine

which is to be met with only in countries that have been subject to subterraneous

“ardentes maximos ignes: igitur penitus ignis, et
“flammæ vapor per intervenia permanans et ardens,
“efficit levem eam terram, et ibi, qui nascitur tophus,
“exigens est, et sine liquore. Ergo cum tres res con-
“simili ratione, ignis vehementia formatæ in unam
“pervenerint mixtionem, repente recepto liquore una
“cohærescant, et celeriter humore duratae solidantur,
“neque eas fluctus, neque vis aquæ potest dissolvere.”

About Baia, Puzzole, and Naples, we have an opportunity of remarking the truth of these last words. Several of the piers of the ancient harbour of Puzzole, vulgarly called Caligula's bridge, and which are composed of brick joined with this sort of cement, are still standing in the sea, though much exposed to the waves; and upon every part of the shore you find large masses of brick-walls rounded and polished by friction in the sea, the brick and mortar making one body, and appearing like a variegated stone. Large pieces of old walls are likewise often cut out into square pieces, and made use of in modern buildings instead of stone.

Soon after the first quotation, Pliny says, “Si ergo
“in his locis aquarum ferventes inveniuntur fontes, et
“in montibus excavatis calidi vaporēs, ipsaque loca ab
“antiquis memorantur pervagantes in agris habuisse
“ardores, videtur esse certum ab ignis vehementia ex
“topho terraue, quemadmodum in fornacibus et à
“calce, ita ex his eruptum esse liquorem. Igitur dif-
fires.

fires. It is; I believe, a sort of lime prepared by nature. This, mixed with water, great or small pumice stones, fragments of lava, and burnt matter, may naturally be supposed to harden into a stone of this kind [g]; and, as water frequently attends eruptions of fire, as will be seen in the accounts I shall give of the formation of the new mountain near Puzzole, I am con-

" similibus, et disparibus rebus correptis, et in unam
 " potestatem collatis, callida humoris jejunitas aqua
 " repente satiata, communibus corporibus latenti calore
 " conservescit et vehementer efficit ea esse, celeriter
 " que una soliditatis percipere virtutem."

[g] Scipione Falcone, a very good observer, in his *Dijcorso naturale dell'i cause et effetti del Vesuvio*, says, that he saw, after the eruption of Vesuvius in 1631 (which was attended with hot water), the mud hardened almost to a stone in a few days; his words are these—" fatta dura a modo di caleina e di pietra non
 " altrimenti di cenere, perché dopò alcuni giorni vi
 " ci e caminato per sopra e si e conosciuta durissima
 " che ci vogliono li picconi per romperla." This account, with other circumstances mentioned in this letter, make it highly probable, that all the *tufai* in the neighbourhood of Vesuvius have been formed by a like operation.

vinced the first matter that issued from Vesuvius, and covered Herculaneum, was in the state of liquid mud. A circumstance strongly favouring my opinion, is, that, about two years ago, I saw the head of an antique statue dug out of this matter within the theatre of Herculaneum; the impression of its face remains to this day in the *tufa*, and might serve as a mould for a cast in plaster of Paris, being as perfect as any mould I ever saw. As much may be inferred from the exact resemblance of this matter, or *tufa*, which immediately covers Herculaneum, to all the *tufas* of which the high grounds of Naples and its neighbourhood are composed. I detached a piece of it sticking to, and incorporated with, the painted stucco of the inside of the theatre of Herculaneum, and shall send it for your inspection [b]. It is very different, as you will see, from the vitri-

[b] This piece is now in the Museum of the Royal Society, together with many other specimens, mentioned in this and in the following letter. M. M.

sed matter called lava, by which it has been generally thought that Herculaneum was destroyed. The village of Resina and some villas stand at present above this unfortunate town.

To account for the very great difference of the matters that cover Herculaneum and Pompeii, I have often thought that, in the eruption of 79, the mountain must have been open in more than one place. A passage in Pliny's letter to Tacitus seems to say as much: "Interim è Vesuvio monte pluribus locis latissimæ flammæ, atque incendia reucebant, quorum fulgor et claritas tenebras noctis pellebat :" so that very probably the matter that covers Pompeii proceeded from a mouth, or crater, much nearer to it than is the great mouth of the Volcano, from whence came the matter that covers Herculaneum. This matter might nevertheless be said to have proceeded from Vesuvius, just as the eruption in the year 1760, which was quite independent of the great crater (being four miles

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miles from it), is properly called an eruption of Vesuvius.

In the beginning of eruptions, Volcanos frequently throw up water mixed with the ashes. Vesuvius did so in the eruption of 1631, according to the testimony of many contemporary writers. The same circumstance happened in 1669, according to the account of Ignazzio Sorrentino, who, by his History of Mount Vesuvius, printed at Naples in 1734, has shewn himself to have been a very accurate observer of the phænomena of the Volcano, for many years that he lived at Torre del Greco, situated at the foot of it. At the beginning of the formation of the new mountain, near Puzzole, water was mixed with the ashes thrown up, as will be seen in two very curious and particular accounts of the fortname of that mountain, which I shall have the pleasure of communicating to you presently; and in 1755, Etna threw up a quantity of water in the beginning of an eruption, as is mentioned

in the letter I sent you last year upon the subject of that magnificent Volcano [i]. Ulloa likewise mentions this circumstance of water attending the eruptions of Volcanos in America. Whenever therefore I find a *tufa* composed exactly like that which immediately covers Herculaneum, and undoubtedly proceeded from Vesuvius, I conclude such a *tufa* to have been produced, by water mixing with the erupted matter at the time of an explosion occasioned by subterraneous fire; and this observation, I believe, will be of more use than any other, in pointing out those parts of the present *terra firma*, that have been formed by explosion. I am convinced, it has often happened that subterraneous fires and exhalations, after having been pent up and confined for some time, and been the cause of earthquakes, have forced their passage, and in venting themselves formed mountains of the matter that confined them, as you will see was the case

[i] Letter IV.

near

near Puzzole in the year 1538, and by evident signs has been so before, in many parts of the neighbourhood of Puzzole; without creating a regular Volcano. The materials of such mountains will have but little appearance of having been produced by fire, to any one unaccustomed to make observations upon the different nature of Volcanos.

If it were allowed to make a comparison between the earth and a human body, one might consider a country replete with combustibles occasioning explosions (which is surely the case here) to be like a body full of humours. When these humours concentrate in one part, and form a great tumour out of which they are discharged freely, the body is less agitated; but when, by any accident, the humours are checked, and do not find free passage through their usual channel, the body is agitated, and tumours appear in other parts of that body, but soon after the humours return again to their former channel. In a similar manner
one

one may conceive Vesuvius to be the present great channel, through which nature discharges some of the foul humours of the earth: when these humours are checked by any accident or stoppage in this channel for any considerable time, earthquakes will be frequent in its neighbourhood, and explosions may be apprehended even at some distance from it. This was the case in the year 1538, Vesuvius having been quiet for near 400 years. There was no eruption from its great crater, from the year 1139 to the great eruption of 1631, and the top of the mountain began to lose all signs of fire. As it is not foreign to my purpose, and will serve to shew how greatly they are mistaken, who place the seat of the fire in the centre, or towards the top, of a Volcano; I will give you a curious description of the state of the crater of Vesuvius, after having been free from eruption 492 years, as related by Bracini, who descended into it not long before the eruption of

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1631 : "The crater was five miles in circumference, and about a thousand paces deep ; its sides were covered with brush wood, and at the bottom there was a plain on which cattle grazed. In the woody parts, boars frequently harboured; in the midst of the plain, within the crater, was a narrow passage, through which, by a winding path, you could descend about a mile amongst rocks and stones, till you came to another more spacious plain covered with ashes : in this plain were three little pools, placed in a triangular form, one towards the East, of hot water, corrosive and bitter beyond measure; another towards the West, of water falter than that of the sea ; the third of hot water, that had no particular taste."

The great increase of the cone of Vesuvius, from that time to this, naturally induces one to conclude, that the whole of the cone was raised in the like manner; and that the part of Vesuvius, called Somma,

Somma, which is now considered as a distinct mountain from it, was composed in the same manner. This may plainly be perceived, by examining its interior and exterior form, and the strata of lava and burnt matter of which it is composed. The ancients, in describing Vesuvius, never mention two mountains. Strabo, Dio, Vitruvius, all agree, that Vesuvius, in their time, shewed signs of having formerly erupted [*k*], and the first compares the

[*k*] Strabo, in his fifth book of Geography, says.
 "Supra hæc loca situs est Vesuvius mons agris cinctus optimis: dempro vertice, qui magna sui parte planus, totus sterilis est, adspicere cincereus, cavernasque ostendens fistularum plenas et lapidum colosse fuliginoso, utpote ab igni exesorum, ut conjecturam facere possit ista loca quondam artifissæ, et crateras ignis habuisse, deinde materia deficiente restinctæ fuisse."

Diodorus Siculus, in his fourth book, describing the voyage of Hercules into Italy, says, "Phlegræus quoque campus is locus appellatur a colle nimirum, qui Aetwæ instar Siculæ magnam vim ignis eructabat; nunc Vesuvius nominatur, multæ inflammationis pristinæ vestigia reservans." And Vitruvius, in the

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crater on its top to an amphitheatre. The mountain now called Somma was, I believe, that which the ancients called Vesuvius: its outside form is conical; its inside, instead of an amphitheatre, is now like a great theatre. I suppose the eruption in Pliny's time to have thrown down that part of the cone next the sea, which would naturally have left it in its present state; and that the conical mountain, or existing Vesuvius, has been raised by the succeeding eruptions: all my observations confirm this opinion. I have seen antient lavas in the plain on the other side of Somma, which could never have proceeded from the present Vesuvius. Serao, a celebrated physician now living at Na-

sith chapter of the second book, says, " Non minus
 " etiam memoratur antiquitus crevisse ardores et abun-
 " dasse sub Vesuvio monte et inde evomuisse circa agros
 " flamas." Tacitus, mentioning the eruption of Ve-
 " suvius in the reign of Tirus, seems to hint likewise at
 former eruptions, in these words: " Jam vero novis
 " cladibus, vel post longam seculorum repetitis af-
 " flictæ, haustæ aut abrutæ fecundissima Campania ora
 " et urbs incendiis vastata."

ples,

ples, in the introduction of his account of the eruption of Vesuvius in 1737 (in which account many of the phænomena of the Volcano are recorded and very well accounted for), says, that at the convent of Dominican Fryars, called the Madona del Arco, some years ago, in sinking a well, at a hundred feet depth, a lava was discovered, and soon after another; so that, in less than three hundred feet depth, the lavas of four eruptions were found. From the situation of this convent, it is clear beyond a doubt, that these lavas proceeded from the mountain called Somma, as they are quite out of the reach of the existing Volcano.

From these circumstances, and from repeated observations I have made in the neighbourhood of Vesuvius, I am sure that no virgin soil is to be found there, and that all is composed of different strata of erupted matter, even to a great depth below the level of the sea. In short, I have not any doubt in my own mind, but that this Vol-

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cano took its rise from the bottom of the sea; and as the whole plain between Vesuvius and the mountains behind Caserta, which is the best part of the Campagna Felice, is (under its good soil) composed of burnt matter, I imagine the sea to have washed the feet of those mountains, until the subterraneous fires began to operate, at a period certainly of a most remote antiquity.

The soil of the Campagna Felice is very fertile; I saw the earth opened in many places last year in the midst of that plain, when they were seeking for materials to mend the road from Naples to Caserta. The stratum of good soil was in general four or five feet thick; under which was a deep stratum of cinders, pumice, fragments of lava, and such burnt matter as abounds near Vesuvius and all Volcanos. The mountains at the back of Caserta are mostly of a sort of lime-stone, and very different from those formed by fire; though Signior Van Vitelli, the celebrated architect, has

MOUNT VESUVIUS, &c. 115

has assured me, that, in the cutting of the famous aqueduct of Caserta through these mountains, he met with some soils, that had been evidently formed by subterraneous fire. The high grounds, which extend from Castel-a-Mare to the point of Minerva towards the island of Caprea, and from the promontory that divides the bay of Naples from that of Salerno, are of lime-stone. The plain of Sorrento, that is bounded by these high grounds, beginning at the village of Vico, and ending at that of Massa, is wholly composed of the same sort of *tufa* as that about Naples, except that the cinders or pumice stones intermixed in it are larger than in the Naples *tufa*. I conceive then that there has been an explosion in this spot from the bottom of the sea. This plain, as I have remarked to be the case with all soils produced by subterraneous fire, is extremely fertile; whilst the ground about it, being of another nature, is not so. The island of Caprea does not shew any signs of having

been formed by subterraneous fire; but is of the same nature as the high grounds last mentioned, from which it has been probably detached by earthquakes, or the violence of the waves. Rovigliano, an island, or rather a rock, in the bay of Castel-a-Mare, is likewise of lime-stone, and seems to have belonged to the original mountains in its neighbourhood: in some of these mountains there are also petrified fish and fossil shells, which I never have found in the mountains] which I suppose to have been formed by explosion [1].

You have now, Sir, before you the nature of the soil, from Caprea to Naples. The soil on which this great metropolis stands has been evidently produced by ex-

[1] Bracini, in his account of the eruption of 1613, says, that he found many sorts of sea shells on Vesuvius after that eruption; and P. Ignatio, in his account of the same eruption, says, that he and his companions picked up many shells likewise at that time upon the mountain: this circumstance would induce one to believe, that the water thrown out of Vesuvius, during that formidable eruption, came from the sea.

plosions,

plosions, some of which seem to have been upon the very spot on which this city is built; all the high grounds round Naples, Paufilipo, Puzzole, Baïa, Misenum, the islands of Procita and Ischia, appear to have been raised by explosion. You can trace still in many of these heights the conical shape that was naturally given them at first, and even the craters out of which the matter issued, though to be sure others of these heights have suffered such changes by the hand of time, that you can only conjecture that they were raised in the like manner, by their composition being exactly the same as that of those mountains which still retain their conical form and craters entire. A *tufa*, exactly resembling the specimen I took from the inside of the theatre of Herculaneum, layers of pumice intermixed with layers of good soil, just like those over Pompeii, and lavas like those of Vesuvius, compose the whole soil of the country that remains to be described.

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The famous grotto anciently cut through the mountain of Pausilipo, to make a road from Naples to Pozzuoli, gives you an opportunity of seeing that the whole of that mountain is *tufa*. The first evident crater you meet with, after you have passed the grotto of Pausilipo, is now the lake of Agnano; a small remain of the subterraneous fire (which must probably have made the basin for the lake, and raised the high grounds which form a sort of amphitheatre round it) serves to heat rooms, which the Neapolitans make great use of in summer, for carrying off diverse disorders, by a strong perspiration. This place is called the Sudatorio di San Germano; near the present bagnios, which are but poor little hovels, there are the ruins of a magnificent ancient bath. About an hundred paces from hence is the Grotto del Cane; I shall only mention, as a further proof of the probability that the lake of Agnano was a Volcano, that vapours of a pernicious quality, as that in the Grotto del

del Cane, are frequently met with in the neighbourhood of Etna and Vesuvius, particularly at the time of, before, and after, great eruptions. The noxious vapour having continued in the same force constantly so many ages, as it has done in the Grotto del Cane (for Pliny mentions this Grotto [^m]), is indeed a circumstance in which it differs from the vapours near Vesuvius and Etna, which are not constant. The cone forming the outside of this supposed Volcano is still perfect in many parts.

Opposite to the Grotto del Cane, and immediately joining to the lake, rises the

[^m] In book xi. c. 93. he observes, that about Sinueffa and Piteoli, "Spiracula vocant--alii Caro--neas scrobes, mortiferum spiritum exhalantes." And Seneca, Nat. Quæst. lib. vi. cap. 28. "Pluribus Italæ locis per quædam foramina pestilens exhalatur vapor, quem non homini ducere, non feræ tutum est. Aves quoque si in illum inciderint, antequam cœlo meliore leniatur, in ipso volatu cadunt, liventque corpora, et non aliter quam per vim elise fauces tument."

mountain called Astruni, which, having, as I imagine, been thrown up by an explosion of a much later date, retains the conical shape and every symptom of a Volcano in much greater perfection than that I have been describing. The crater of Astruni is surrounded with a wall to confine boars and deer (this Volcano having been for many years converted to a royal chace). It may be about six miles or more in circumference: in the plain at the bottom of the crater are two lakes; and in some books there is mention made of a hot spring, which I never have been able to find. There are many huge rocks of lava within the crater of Astruni, and some I have met with also in that of Agnand; the cones of both these supposed Volcanos are composed of *tufa* and strata of loose pumice, fragments of lava and other burnt matter, exactly resembling the strata of Vesuvius. Bartholomeus Fatius, who wrote of the actions of King Alphonso the First (before the new mountain had been formed

near

near Puzzole), conjectured that Afruni had been a Volcano. These are his words : “*Loca Neapoli quatuor millia passuum
proximus, quem vulgo Eistrones vocant,
nos umum è Phlegreis Campis ab ardore
insepundum putamus.*” There is no entrance into the crater of either Afruni or Agnano, except one, evidently made by art, and they both exactly correspond with Strabo’s description of Avernus ; the same may be said of the Solfaterra and the Monte Gairo, or Barbaro as it is sometimes called, which I shall describe presently.

Near Afruni and towards the sea rises the Solfaterra, which not only retains its cone and crater, but much of its former heat. In the plain within the crater, smoak issues from many parts, as also from its sides ; here, by means of stones and tiles heaped over the crevices through which the smoak passes, they collect in an awkward manner what they call *salsi armaciæ* ; and from the sand of the plain they extract

extract sulphur and alum. This spot, well attended to, might certainly produce a good revenue, whereas I doubt if they have hitherto ever cleared 200 £. a year by it. The hollow sound produced by throwing a heavy stone on the plain of the crater of the Solfaterra seems to indicate, that it is supported by a sort of arched natural vault; and one is induced to think that there is a pool of water beneath this vault (which boils by the heat of a subterraneous fire still deeper), by the very moist stream that issues from the cracks in the plain of the Solfaterra, which, like that of boiling water, runs off a sword or knife, presented to it, in great drops. On the outside, and at the foot of the cone of the Solfaterra, towards the lake of Agnano, water rushes out of the rocks, so hot, as to raise the quicksilver in Fahrenheit's thermometer to the degree of boiling water [n].

[n] I have remarked, that, after a great fall of rain, the degree of heat in this water is much less, which will account for what the Padre Torre says (in his *fact*:

a fact of which I was myself an eye-witness. This place, well worthy the observation of the curious, has been taken little notice of; it is called the *Pisciarelli*. The common people of Naples have great faith in the efficacy of this water; and make much use of it in all cutaneous disorders, as well as for another disorder that prevails here. It seems to be impregnated chiefly with sulphur and alum. When you approach your ear to the rocks of the Pisciarelli, from whence this water ouzes, you hear a horrid boiling noise, which seems to proceed from the huge cauldron, that may be supposed to be under the plain of the Solfaterra. On the other side of the Solfaterra, next the sea, there is a rock, which has communicated with the sea, till part of it was cut away to make the road to Puzzole; this was undoubtedly a consider-

book, entitled, *Histoire et Phenomenes du Vesuve*, that, when he tried it in company with Monsieur de la Condamine, the degree of heat, upon Reaumur's thermometer, was 68° .

able lava, that ran from the Solfaterra when it was an active Volcano. Under this rock of lava, which is more than seventy feet high, there is a stratum of pumice and ashes. This ancient lava is about a quarter of a mile broad; you meet with it abruptly before you come in sight of Puzzole, and it finishes as abruptly within about an hundred paces of the town. I have often thought that many quarries of stone, upon examination, would be found to owe their origin to the same cause, though time may have effaced all signs of the Volcano from whence they proceeded. Except this rock, which is evidently lava and full of vitrifications like that of Vesuvius, all the rocks upon the coast of Baia are of *tufa*.

I have observed in the lava of Vesuvius and Etna, as in this, that the bottom, as well as the surface of it, was rough and porous, like the cinders or scoriae from an iron foundry; and that for about a foot from the surface and from the bottom, they were

were not near so solid and compact as towards the centre; which must undoubtedly proceed from the impression of the air upon the vitrified matter whilst in fusion. I mention this circumstance, as it may serve to point out true lava's with more certainty. The ancient name of the Solfaterra was, *Forum Vulcani*; a strong proof of its origin from subterraneous fire. The degree of heat, that the Solfaterra has preserved for so many ages, seems to have calcined the stones upon its cone, and in its crater, as they are very white, and crumble easily in the hottest parts.

We come next to the new mountain near Puzzole, which, being of so very late a formation, preserves its conical shape entire, and produces as yet but a very slender vegetation. It has a crater almost as deep as the cone is high, which may be near a quarter of a mile perpendicular, and is in shape a regular inverted cone. At the basis of this new mountain (which is more than three miles in circumference), the

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sand upon the sea shore, and even that which is washed by the sea itself, is burning hot for above the space of an hundred yards; if you take up a handful of the sand below water, you are obliged to get rid of it directly, on account of its intense heat.

I had been long very desirous of meeting with a good account of the formation of this new mountain, because, proving this mountain to have been raised by mere explosion in a plain, would prove at the same time, that all the neighbouring mountains, which are composed of the same materials, and have exactly or in part the same form, were raised in the like manner; and that the seat of fire, the cause of these explosions, lies deep; which I have every reason to think.

Fortunately, I lately found two very good accounts of the phænomena that attended the explosion, which formed the new mountain, published a few months after the event. As I think them very curious,

rious, and greatly to my purpose, and as they are rare, I will give you a literal translation of such extracts as relate to the formation of the Monte Nuovo. They are bound in one volume [o].

The title of the first is, *Dell Incendio di Pozzuolo, Marco Antonio delli Falconi all' Illusterrissima Signora Marchesa della Padula nel MDXXXVIII.*

At the head of the second is, *Ragionamento del Terremoto, del Nuovo Monte, del Aprimento di Terra in Pozzuolo nell' Anno 1538, é della significatione d'essi. Per Piero Giacomo da Toledo;* and at the end of the book, *Stampata in Nap. per Giovanni Sulzbach Alemano, a 22di Genaro 1539, con gratia, é privilegio.*

" First then (says Marco Antonio delli Falconi), will I relate simply and exactly " the operations of nature, of which I was " either myself an eye-witness, or as they " were related to me by those who had

[o] This very scarce volume has been presented by Sir William Hamilton to the British Museum. M. M.

" been

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“ been witnesses of them. It is now two
“ years that there have been frequent
“ earthquakes at Pozzuolo, at Naples,
“ and the neighbouring parts; on the
“ day and in the night before the ap-
“ pearance of this eruption, above twenty
“ shocks great and small were felt at the
“ abovementioned places. The eruption
“ made its appearance the 29th of Septem-
“ ber 1538, the feast of St. Michael the
“ angel; it was on a Sunday, about an
“ hour in the night; and, as I have been
“ informed, they began to see on that spot,
“ between the hot baths or sweating
“ rooms, and Trepergule, flames of fire,
“ which first made their appearance at
“ the baths, then extended towards Tre-
“ pergule, and fixing in the little valley that
“ lies between the Monte Barbaro and the
“ hillock called del Pericolo (which was
“ the road to the lake of Avernus and
“ the baths), in a short time the fire in-
“ creased to such a degree, that it burst
“ open the earth in this place, and threw
“ up

“ up so great a quantity of ashes and
“ pumice stones mixed with water, as
“ covered the whole country; and in Na-
“ ples a shower of these ashes and water
“ fell great part of the night. The next
“ morning, which was Monday, and the
“ last of the month, the poor inhabitants
“ of Pozzuolo, struck with so horrible a
“ sight, quitted their habitations, cover-
“ ed with that muddy and black shower,
“ which continued in that country the
“ whole day, flying death, but with faces
“ painted with its colours; some with their
“ children in their arms, some with sacks
“ full of their goods; others leading an-
“ als, loaded with their frightened family,
“ towards Naples; others carrying quan-
“ tities of birds of various sorts, that had
“ fallen dead at the time the eruption
“ began; others again with fish which they
“ had found, and were to be met with
“ in plenty upon the shore, the sea hav-
“ ing been at that time considerably dried
“ up. Don Petro di Toledo, Viceroy.

“ of the kingdom, with many gentlemen,
“ went to see so wonderful an appear-
“ ance; I also, having met with the most
“ honourable and incomparable gentle-
“ man, Signior Fabritio Moramaldo, on
“ the road, went and saw the eruption
“ and the many wonderful effects of it.
“ The sea towards Baïa had retired a
“ considerable way; though, from the
“ quantity of ashes and broken pumice
“ stones thrown up by the eruption, it
“ appeared almost totally dry. I saw
“ likewise two springs in those lately-dis-
“ covered ruins, one before the house that
“ was the Queen’s, of hot and salt water;
“ the other of fresh and cold water, on
“ the shore, about 250 paces nearer to
“ the eruption: some say, that, still nearer
“ to the spot where the eruption hap-
“ pened, a stream of fresh water issued
“ forth like a little river. Turning to-
“ wards the place of the eruption, you
“ saw mountains of smoak, part of which
“ was very black and part very white,
“ rise

" rise up to a great height; and in the
" midst of the smoak, at times, deep-co-
" loured flames burst forth with huge
" stones and ashes, and you heard a noise
" like the discharge of a number of great
" artillery.. It appeared to me as if Ty-
" pheus and Enceladus from Ischia and
" Etna with innumerable giants, or those
" from the Campi Phlegrei (which, ac-
" cording to the opinions of some, were
" situated in this neighbourhood), were
" come to wage war again with Jupiter.
" The natural historians may perhaps rea-
" sonably say, that the wise poets meant
" no more by giants, than exhalations,
" shut up in the bowels of the earth,
" which, not finding a free passage, open
" one by their own force and impulse, and
" form mountains, as those which occa-
" sioned this eruption have been seen to
" do; and methought I saw those torrents
" of burning smoak that Pindar describes
" in an eruption of Etna, now called
" Mon Gibello, in Sicily; in imitation of
" which,

" which, as some say, Virgil wrote these
" lines:

" Ipse sed horrificis juxta tonat Aetna ruinis, &c.

" After the stones and ashes with clouds
" of thick smoak had been sent up, by
" the impulse of the fire and windy ex-
" halation (as you see in a great cauldron
" that boils), into the middle region of
" the air, overcome by their own natural
" weight, when from distance the strength
" they had received from impulse was
" spent, rejected likewise by the cold and
" unfriendly region, you saw them fall
" thick, and, by degrees, the condensed
" smoak clear away, raining ashes with
" water and stones of different sizes, ac-
" cording to the distance from the place:
" then, by degrees, with the same noise
" and smoak, it threw out stones and ashes
" again, and so on by fits. This con-
" tinued two days and nights, when the
" smoak and force of the fire began to
" abate. The fourth day, which was
" Thursday,

" Thursday, at 22 o'clock, there was so
" great an eruption, that, as I was in the
" gulph of Puzzole, coming from Ischia;
" and not far from Misenum, I saw, in
" a short time, many columns of smoak
" shoot up, with the most terrible noise
" I ever heard; and, bending over the sea,
" came near our boat, which was four
" miles or more from the place of their
" birth; and the quantity of ashes, stones,
" and smoak, seemed as if they would
" cover the whole earth and sea. Stones,
" great and small, and ashes more or less,
" according to the impulse of the fire
" and exhalations, began to fall, so that
" a great part of this country was cover-
" ed with ashes; and many, that have seen
" it, say, they reached the vale of Diana,
" and some parts of Calabria, which are
" more than 150 miles from Pozzuolo.
" The Friday and Saturday nothing but
" a little smoak appeared; so that many,
" taking courage, went upon the spot,
" and say, that with the stones and ashes

" thrown up, a mountain has been form'd
" in that valley, not less than three
" miles in circumference, and almost, as
" high as the Monte Barbaro, which is
" near it, covering the Canettaria, the castle
" of Trepergule, all those buildings and
" the greatest part of the baths that were
" about them; extending South towards
" the sea, North as far as the lake of
" Avernus, West to the Sudatory, and
" joining East to the foot of the Monte
" Barbaro; so that this place has changed
" its form and face in such a manner as
" not to be known again: a thing almost
" incredible, to those who have not seen
" it, that in so short a time so considera-
" ble a mountain could have been form-
" ed. On its summit there is a mouth
" in the form of a cup, which may be a
" quarter of a mile in circumference,
" though some say it is as large as our
" market-place at Naples, from which
" there issues a constant smoak; and
" though I have seen it only at a distance,

" it

“ it appears very great. The Sunday following, which was the 6th of October, many people going to see this phænomenon, and some having ascended half the mountain, others more, about 22 o'clock there happened so sudden and horrid an eruption, with so great a smoak, that many of these people were stifled, some of which could never be found. I have been told, that the number of the dead or lost amounted to twenty-four. From that time to this, nothing remarkable happened; it seems as if the eruption returned periodically, like the ague or gout. I believe henceforward it will not have such force; though the eruption of the Sunday was accompanied with showers of ashes and water, which fell at Naples, and were seen to extend as far as the mountain of Somma, called Vesuvius by the ancients; and, as I have often remarked, the clouds of smoak proceeding from the eruption moved in a direct line

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" towards that mountain, as if these places
" had a correspondence and connection
" one with the other. In the night, many
" beams and columns of fire were seen
" to proceed from this eruption, and some
" like flashes of lightning [p]. We have
" then, many circumstances for our ob-
" servation, the earthquakes, the eruption,
" the drying up of the sea, the quantity
" of dead fish and birds, the birth of
" springs, the shower of ashes with water
" and without water, the innumerable trees
" in that whole country, as far as the
" Grotto of Lucullus, torn from their
" roots, thrown down, and covered with
" ashes, that it gave one pain to see them:
" and as all these effects were produced by
" the same cause that produces earth-
" quakes; let us first enquire how earth-
" quakes are produced; and from thence
" we may easily comprehend the cause of
" the abovementioned events." Then

[p] Here again we have an example of the electrical
fire attending a great eruption.

follows

follows a dissertation on earthquakes, and some curious conjectures relative to the phænomena which attended this eruption, clearly and well expressed, considering, as the author himself apologizes, that at that time the Italian language had been little employed on such subjects.

The account of the formation of the Monte Nuovo, by Pietro Giacomo di Toledo, is given in a dialogue between the feigned personages of Peregrino and Svenzano; the former of which says, " It is now two years that this province of Campagna has been afflicted with earthquakes, the country about Pozzuolo much more so than any other parts; but the 27th and the 28th of the month of September last, the earthquakes did not cease day or night, in the abovementioned city of Pozzuolo; that plain, which lies between the lake of Averno, the Monte Barbaro, and the sea, was raised a little, and many cracks were made in it, from some of which issued water; and at the same

“ same time the sea, which was very near the
“ plain, dried up about two hundred paces,
“ so that the fish were left on the sand,
“ a prey to the inhabitants of Pozzuolo.
“ At last, on the 29th of the said month,
“ about two hours in the night, the earth
“ opened near the lake, and discovered a
“ horrid mouth, from which were vo-
“ mited furiously, smoak, fire, stones, and
“ mud composed of ashes; making, at the
“ time of its opening, a noise like very
“ loud thunder: the fire, that issued from
“ this mouth, went towards the walls of
“ the unfortunate city; the smoak was
“ partly black and partly white; the black
“ was darker than darkness itself, and the
“ white was like the whitest cotton: these
“ smoaks, rising in the air, seemed as if
“ they would touch the vault of heaven;
“ the stones that followed were, by the
“ devouring flames, converted to pumice,
“ the size of which (of some I say) were
“ much larger than an ox. The stones
“ went about as high as a cross-bow can
“ carry,

it carry, and then fell down, sometimes
“on the edge, and sometimes into the
“mouth itself. It is very true that many
“of them in going up could not be seen,
“on account of the dark smoak; but,
“when they returned from the smoaky
“heat, they shewed plainly where they
“had been, by their strong smell of fetid
“sulphur, just like stones that have been
“thrown out of a mortar, and have pas-
“sed through the smoak of inflamed gun-
“powder. The mud was of the colour
“of ashes, and at first very liquid, then
“by degrees less so; and in such quan-
“tities, that in less than twelve hours,
“with the help of the abovementioned
“stones, a mountain was raised of a
“thousand paces in height. Not only
“Pozzuolo and the neighbouring country
“was full of this mud, but the city of
“Naples also, the beauty of whose pa-
“laces were, in a great measure, spoiled
“by it. The ashes were carried as far as
“Calabria by the force of the winds,
“burning

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“ burning up in their passage the grafts
“ and high trees, many of which were
“ borne down by the weight of them.
“ An infinity of birds also, and number-
“ less animals of various kinds, covered
“ with this sulphureous mud, gave them-
“ selves up a prey to man. Now this
“ eruption lasted two nights and two days
“ without intermission, though, it is true,
“ not always with the same force, but
“ more or less: when it was at its greatest
“ height, even at Naples you heard a
“ noise or thundering like heavy artillery
“ when two armies are engaged. The
“ third day the eruption ceased, so that
“ the mountain made its appearance un-
“ covered, to the no small astonishment
“ of every one who saw it. On this
“ day, when I went up with many peo-
“ ple to the top of this mountain; I saw
“ down into its mouth, which was a round
“ concavity of about a quarter of a mile
“ in circumference, in the middle of which
“ the stones that had fallen were boile-

“ ing

"ing up, just as in a great cauldron of
"water that boils on the fire. The fourth
"day it began to throw up again, and the
"seventh much more, but still with less
"violence than the first night; it was at this
"time that many people, who were un-
"fortunately on the mountain, were either
"suddenly covered with ashes, smothered
"with smoak, or, knocked down by stones,
"burnt by the flame, and left dead on the
"spot. The smoak continues to this
"day [q], and you often see in the night-
"time fire in the midst of it. Finally, to
"complete the history of this new and
"unforeseen event, in many parts of the
"new-made mountain, sulphur begins to
"be generated." Giacomo di Toledo, to-
wards the end of his dissertation upon

[q] The cup, or crater, on the top of the new mountain is now covered with shrubs; but I discovered at the bottom of it, in the year 1770, amidst the bushes, a small hole, which exhales a constant hot and damp vapour, just such as proceeds from boiling water, and with as little smell; the drops of this steam hang upon the neighbouring bushes.

the

the phænomena attending this eruption, says, that the lake of Avernus had a communication with the sea; before the time of the eruption; and that he apprehended that the air of Puzzole might come to be affected in summer time, by the vapours from the stagnated waters of the lake; which is actually the case.

You have, Sir, from these accounts, an instance of a mountain, of a considerable height and dimensions, formed in a plain, by mere explosion, in the space of forty-eight hours. The earthquakes having been sensibly felt at a great distance from the spot where the opening was made, proves clearly, that the subterraneous fire was at a great depth below the surface of the plain; it is as clear that those earthquakes, and the explosion, proceeded from the same cause, the former having ceased upon the appearance of the latter. Does not this circumstance evidently contradict the system of M. Buffon, and of all the natural historians, who have placed the seat of the fire

of

of Volcanos towards the center, or near the summit of the mountains, which they suppose to furnish the matter emitted? Did the matter which proceeds from a Volcano in an eruption come from so inconsiderable a depth as they imagine, that part of the mountain situated above their supposed seat of the fire must necessarily be destroyed, or dissipated in a very short time: on the contrary, an eruption usually adds to the height and bulk of a Volcano; and who, that has had an opportunity of making observations on Volcanos, does not know, that the matter they have emitted for many ages, in lavas, ashes, smoak, &c. could it be collected together, would more than suffice to form three such mountains as the simple cone or mountain of the existing Volcano? With respect to Vesuvius, this could be plainly proved; and I refer to my letter upon the subject of Etna, to shew the quantity of matter thrown up in one single eruption, by that terrible Volcano. Another proof, that the real seat of the fire of Volcanos

canos lies even greatly below the general level of the country whence the mountain springs; is, that was it only at an inconsiderable depth below the basis of the mountain, the quantity of matter thrown up would soon leave so great a void immediately under it, that the mountain itself must undoubtedly sink and disappear after a few eruptions.

In the above accounts of the formation of the new mountain, we are told that the matter first thrown up, was mud composed of water and ashes, mixed with pumice stones and other burnt matter: on the road leading from Puzzole to Cuma, part of the cone of this mountain has been cut away, to widen the road. I have there seen that its composition is a *tufa* intermixed with pumice, some of which are really of the size of an ox, as mentioned in Toledo's account, and exactly of the same nature as the *tufa* of which every other high ground in its neighbourhood is composed; similar also to that which covers Hercul-

Herculaneum. According to the above accounts; after the muddy shower ceased, it rained dry ashes : this circumstance will account for the strata of loose pumice and ashes, that are generally upon the surface of all the *tufas* in this country, and which were most probably thrown up in the same manner. At the first opening of the earth, in the plain near Puzzole, both accounts say, that springs of water burst forth ; this water, mixing with the ashes, certainly occasioned the muddy shower ; when the springs were exhausted, there must naturally have ensued a shower of dry ashes and pumice, of which we have been likewise assured. I own, I was greatly pleased at being in this manner enabled to account so well for the formation of these *tufa* stones and the veins of dry and loose burnt matter above them, of which the soil of almost the whole country I am describing is composed ; and I do not know that any one has ever attended to this circumstance, though I find that many authors, who have

described this country, have suspected that parts of it were formed by explosion. Wherever then this sort of *sufa* is found, there is certainly good authority to suspect its having been formed in the same manner as the *sufa* of this new mountain; for, as I said before, Nature is generally uniform in all her operations.

It is commonly imagined that the new mountain rose out of the Lucrine lake, which was destroyed by it; but in the above account, no mention is made of the Lucrine lake; it may be supposed, then, that the famous dam, which Strabo and many other ancient authors mention to have separated that lake from the sea, had been ruined by time or accident, and that the lake became a part of the sea before the explosion of 1538.

If the above-described eruption was terrible, that which formed the Monte Barbaro (or Gauro, as it was formerly called), must have been dreadful indeed. It joins immediately to the new mountain, which in

in shape and composition it exactly resembles; but it is at least three times as considerable. Its crater cannot be less than six miles in circumference; the plain within the crater, one of the most fertile spots I ever saw, is about four miles in circumference: there is no entrance to this plain, but one on the East side of the mountain, made evidently by art; in this section you have an opportunity of seeing that the matter of which the mountain is composed is exactly similar to that of the Monte Nuovo. It was this mountain that produced (as some authors have supposed) the celebrated Falernian wine of the ancients.

Cuma, allowed to have been the most ancient city of Italy, was built on an eminence, which is likewise composed of *tufa*, and may be naturally supposed a section of the cone formed by a very ancient explosion.

The lake of Avernus fills the bottom of the crater of a mountain, undoubtedly pro-

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duced by explosion, and whose interior and exterior form, as well as the matter of which it is composed, exactly resemble the Monte Barbaro and Monte Nuovo. At that part of the basis of this mountain which is washed by the sea of the bay of Puzzole, the sand is still very hot, though constantly washed by the waves; and into the cone of the mountain, near this hot sand, a narrow passage of about 100 paces in length is cut, and leads to a fountain of boiling water, which, though brackish, boils fish and flesh without giving them any bad taste or quality, as I have experienced more than once. This place is called Nero's bath, and is still made use of for a sudatory, as it was by the ancients; the steam that rises from the hot fountain abovemeationed, confined in the narrow subterraneous passage, soon produces a violent perspiration upon the patient who sits therein. This bath is reckoned a great specifick in that distemper which is supposed to have made its appearance

at

at Naples before it spread its contagion over the other parts of Europe.

Virgil and other ancient authors say, that birds could not fly with safety over the lake of Avernus, but that they fell therein; a circumstance favouring my opinion, that this was once the mouth of a Volcano. The vapour of the sulphur and other minerals must undoubtedly have been more powerful, the nearer we go back to the time of the explosion of the Volcano; and I am convinced that there are still some remains of those vapours upon this lake, as I have observed there are very seldom any water-fowl upon it; and that when they do go there, it is but for a short time; whilst all the other lakes in the neighbourhood are constantly covered with them, in the winter season. Upon Mount Vesuvius, in the year 1766, during an eruption, when the air was impregnated with noxious vapours, I have myself picked up dead birds frequently.

The castle of Baia stands upon a considerable eminence, composed of the usual *tufa* and strata of pumice and ashes; from which I concluded I should find some remains of the craters from whence the matter issued: accordingly, having ascended the hill, I soon discovered two very visible craters, just behind the castle.

The lake called the Mare-morto was also, most probably, the crater, from whence issued the materials which formed the Promontory of Misenum, and the high grounds around this lake. Under the ruins of an ancient building, near the point of Misenum, in a vault, there is a vapour, or *mofete*, exactly similar in its effects to that of the Grotto del Cane, as I have often experienced.

The form of the little island of Nisida shews plainly its origin [r]. It is half a

[r] The noxious vapours which Lucan mentions to have prevailed at Nisida, favour my opinion as to its origin:

“ — Tali spiramine Nefis.
“ Emittit stygium nebuloſis aëra ſaxis.”

Lucan. lib. vi.
hollow

hollow cone of a Volcano cut perpendicularly ; the half crater forms a little harbour called the Porto Pavone ; I suppose the other half of the cone to have been detached into the sea by earthquakes, or perhaps by the violence of the waves, as the part that is wanting is the side next to the open sea.

The fertile and pleasant island of Procida shews also most evident signs of its production by explosion, the nature of its soil being directly similar to that of Baia and Puzzole ; this island seems really, as was imagined by the ancients, to have been detached from the neighbouring island of Ischia.

There is no spot, I believe, that could afford a more ample field for curious observations, than the island of Ischia, called Enaria, Inarime, and Pithecusa, by the ancients. I have visited it three times ; and this summer passed three weeks there, during which time I examined, with attention, every part of it. Ischia is eighteen

miles in circumference: the whole of its soil is the same as that near Vesuvius, Naples, and Puzzole. There are numberless springs, hot, warm, and cold [s], dispersed over the whole island, the waters of which are impregnated with minerals of various sorts; so that, if you give credit to the inhabitants of the country, there is no disorder but what finds its remedy here. In the hot months (the season for making use of these baths), those who have occasion for them flock hither from Naples. A charitable institution sends and maintains three hundred poor patients at the baths of Gurgitelli every season. By what I could learn of these poor patients, those baths have really done wonders, in cases attended with obstinate tumours, and in contractions of the tendons and muscles. The patient begins by bathing, and then is buried in the hot sand near the sea. In

[s] Giulio Cesare Capaccio, in his account of this island, says, that there are eleven springs of cold water, and thirty-five of hot and mineral waters,

many

many parts of the island, the sand is burning hot, even under water. The sand on some parts of the shore is almost entirely composed of particles of iron ore; at least they are attracted by the load-stone, as I have experienced. Near that part of the island called Lacco, there is a rock of an ancient lava, forming a small cavern, which is shut up with a door; this cavern is made use of to cool liquors and fruit, which it does in a short time as effectually as ice. Before the door was opened, I felt the cold to my legs very sensibly; but when it was opened, the cold rushed out so as to give me pain; and within the grotto it was intolerable. I was not sensible of wind attending this cold; though upon Mount Etna and Mount Vesuvius, where there are caverns of this kind, the cold is evidently occasioned by a subterraneous wind: the natives call such places *ventaroli*. May not the quantity of nitre, with which all these places abound, account in some measure for such extreme cold?

cold? My thermometer was unluckily broken, or I would have informed you of the exact degree of the cold in this *vettaroli* of Ischia, which is by much the strongest in its effects I ever felt. The ancient lavas of Ischia shew, that the eruptions there have been very formidable; and history informs us, that its first inhabitants were driven out of the island by the frequency and the violence of them. There are some of these ancient lavas not less than two hundred feet in depth. The mountain of St. Nicola, on which there is at present a convent of hermits, was called by the ancients Epomeus; it is as high, if not higher, than Vesuvius, and appears to me to be a section of the cone of the ancient and principal Volcano of the island, its composition being all *tufa* or lava. The cells of the convent abovementioned are cut out of the mountain itself; and there you see plainly that its composition no way differs from the matter that covers Herculaneum, and forms the Monte Nuovo.

There

There is no sign of a crater on the top of this mountain, which rises almost to a sharp point: time, and other accidents, may be reasonably supposed to have worn away this distinctive mark of its having been formed by explosion; as I have seen to be the case in other mountains, formed evidently by explosion, on the flanks of Etna and Vesuvius. Strabó, in his 5th book; upon the subject of this island, quotes Timæus, as having said, that, a little before his time, a mountain in the middle of Pithecusa, called Epomeus, was shook by an earthquake, and vomited flames.

There are many other rising grounds in this island, that, from the nature of their composition, must lead one to think the same as to their origin. Near the village of Castiglione, there is a mountain formed surely by an explosion of a much later date, having preserved its conical form and crater entire, and producing as yet but a slender vegetation: there is no account, however, of the date of this eruption.

Nearer

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Nearer the town of Ischia, which is on the sea shore; at a place called *Le Cremate*, there is a crater, from which, in the year 1301 or 1302, a lava ran quite into the sea; there is not the least vegetation on this lava, but it is nearly in the same state as the modern lavas of Vesuvius. Pontano, Maranti, and D. Francesco Lombardi, have recorded this eruption; the latter of whom says, that it lasted two months; that many men and beasts were killed by the explosion; and that a number of the inhabitants were obliged to seek for refuge at Naples and in the neighbouring islands.

In short, according to my idea, the island of Ischia must have taken its rise from the bottom of the sea, and been increased to its present size by divers later explosions. This is not extraordinary, when history tells us (and from my own observation I have reason to believe) that the Lipary islands were formed in the like manner. There has been no eruption in Ischia since that just mentioned, but earthquakes

quakes are very frequent there; two years ago, as I was told, they had a very considerable shock of an earthquake in this island.

Father Goree's account of the formation of the new island in the Archipelago (situated between the two islands called Kammeni, and near that of Santorini) of which he was an eye-witness, strongly confirms the probability of the conjectures I venture to send you, relative to the formation of those islands and that part of the continent above described: it seems likewise to confirm the accounts given by Strabo, Pliny, Justin, and other ancient authors, of many islands in the Archipelago, formerly called the Ciclades, having sprung up from the bottom of the sea [t] in the

[t] By having remarked, that all the implements of stone brought by Mess. Banks and Solander from the new-discovered islands in the South-Seas, are evidently of such a nature as are only produced by Volcanos: and as these gentlemen have assured me, that no other kind of stone is to be met with in the islands; I am like

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like manner. According to Pliny, in the 4th year of the cxxxvth Olympiad, 237 years before the Christian æra, the island of Thera (now Santorini) and Theresia were formed by explosion; and, 130 years later, the island Hiera (now called the great Kammeni) rose up. Strabo describes the birth of this island in these words: “In the middle space between Thera and Therasia flames burst out of the sea for four days, which, by degrees, throwing up great masses, as if they had been raised by machines, they formed an island of twelve stadia in circuit.” And Justin says of the same island, “Eodem anno inter insulas Theramenem et Theresiam, medio utriusque ripæ et maris spatio, terræ motus fuit: in quo, cum admirazione navigantium, repente ex profundo cum calidis aquis Insula emerit.”

induced to think, that these islands (at so great a distance from any continent) may have likewise been pushed up from the bottom of the sea by like explosions.

Pliny

Pliny mentions also the formation of Aspronisi, or the White Island, by explosion, in the time of Vespasian. It is known, likewise, that in the year 1628, one of the islands of the Azores, near the island of St. Michael, rose up from the bottom of the sea, which was in that place 160 fathoms deep; and that this island, which was raised in fifteen days, is three leagues long, a league and a half broad, and rises three hundred and sixty feet above water.

Father Goree, in his account of the formation of the new island in the Archipelago, mentions two distinct matters that entered into the composition of this island, the one black, the other white. Aspronisi, probably from its very name, is composed of the white matter, which if, upon examination, it proves to be a *tufa*, as I strongly suspect, I should think myself still more grounded in my conjectures; though I must confess, as it is, I have scarcely a doubt left with respect to the country I have been describing having been thrown

up

up in a long series of ages by various explosions from subterraneous fire. Surely there are at present many existing Volcanos in the known world; and the memory of many others have been handed down to us by history. May there not therefore have been many others, of such ancient dates as to be out of the reach of history [u]?

Such wonderful operations of Nature are certainly intended by all-wise Providence for some great purpose. They are not confined to any one part of the globe; for there are Volcanos existing in the four quarters of it. We see the great fertility of the soil thrown up by explosion, in part of the country I have described; which on that account was called by the ancients

[u] Any one, the least conversant in Volcanos, must be struck with the numberless evident marks of them the whole road from the lake of Albano to Radicofani, between Naples and Florencia; and yet, though this soil bears such fresh and undoubted marks of its origin; no history reaches the date of any one eruption in these parts.

Campania

Campania Felix. The same circumstance is evident in Sicily, justly esteemed one of the most fertile spots in the world, and the granary of Italy. May not subterraneous fire be considered as the great plough (if I may be allowed the expression) which Nature makes use of to turn up the bowels of the earth, and afford us fresh fields to work upon, whilst we are exhausting those we are actually in possession of, by the frequent crops we draw from them? Would it not be found, upon enquiry, that many precious minerals must have remained far out of our reach, had it not been for such operations of Nature? It is evidently so in this country. But such great enquiries would lead me far indeed. I will only add a reflection, which my own little experience in this branch of natural history furnishes me with.. It is, that we are apt to judge of the great operations of Nature on too confined a plan. When first I came to Naples, my whole attention, with respect to natural history, was confined to Mount

M Vesuvius,

Vesuvius, and the wonderful phænomena attending a burning mountain : but, in proportion as I began to perceive the evident marks of the same operation having been carried on in the different parts above described, and likewise in Sicily in a greater degree, I looked upon Mount Vesuvius only as a spot on which Nature was at present active ; and thought myself fortunate in having an opportunity of seeing the manner in which one of her great operations (an operation, I believe, much less out of her common course than is generally imagined) was effected.

Such remarks as I have made on the eruptions of Mount Vesuvius, during my residence at Naples, have been transmitted to the Royal Society, who have done them more honour than they deserved. Many more might be made upon this active Volcano, by a person who had leisure, a previous knowledge of the natural history of the earth, a knowledge of chemistry, and was practised in physical experiments, particularly

ticularly those of electricity [*w*]. I am convinced, that the smoak of Volcanes contains always a portion of electrical matter; which is manifest at the time of great eruptions, as is mentioned in my account of the great eruption of Vesuvius in 1767. The peasants in the neighbourhood of my villa, situated at the foot of Vesuvius, have

[*w*] May not the air in countries replete with sulphur be more impregnated with electrical matter than the air of other soils? and may not the sort of lightning, which is mentioned by several ancient authors to have fallen in a serene day, and was considered as an omen, have proceeded from such a cause?

Horace says, Ode xxxiv.

" — Namque Diespeter

" Igni corusco nubila dividens

" Plerumque per purum tonantes

" Egit equos volucremque currum."

" Non alias cælo ceciderunt plura fereno

" Fulgura ——" Virgil. Georgic. i.

" Aut cum terribili percussus fulmine civis

" Luce serenaat vitalia lumina liquit."

Cic. i. de Divin. n. 18.

" — Sabinos petit aliquanto tristior, quod sacrificanti
" hostia aufugerat: quodque tempestate serena to-
" nuerat." Sueton. Tit. cap. 10.

M. 2

assured

assured me, that, during the eruption last mentioned, they were more alarmed by the lightning and balls of fire that fell about them with a crackling noise, than by the lava and the usual attendants of an eruption. I find in all the accounts of great eruptions mention made of this sort of lightning, which is distinguished here by the name of *Ferilli*. Bracini, in his account of the great one of Vesuvius in 1631, says, that the column of smoak, which issued from its crater, went over near an hundred miles of country, and that several men and beasts were struck dead by lightning, issuing from this smoak in its course.

The nature of the noxious vapours, called here *mofete*, that are usually set in motion by an eruption of the Volcano, and are then manifest in the wells and subterraneous parts of its neighbourhood, seem likewise to be little understood. From some experiments very lately made, by the ingenious Dr. Nooth, on the *mofete* of the Grotto del Cane, it appears that all its known

known qualities and effects correspond with those attributed to fixed air. Just before the eruption of 1767, a vapour of this kind broke into the King's chapel at Portici, by which a servant, opening the door of it, was struck down. About the same time, as his Sicilian Majesty was shooting in a paddock near the palace, a dog dropped down, as was supposed, in a fit; a boy going to take him up dropped likewise; a person present, suspecting the accident to have proceeded from a *mofete*, immediately dragged them both from the spot where they lay, in doing which, he was himself sensible of the vapour; the boy and the dog soon recovered. His Sicilian Majesty did me the honour of informing me himself of this accident soon after it had happened. I have met with these *mofetes* often, when I have been making my observations on the borders of Mount Vesuvius, particularly in caverns, and once on the Solfaterra. The vapour affects the nostrils, throat, and stomach, just as the

spirit of Martshorn, or any strong volatile salts; and would soon prove fatal, if you did not immediately remove from it. Under the ancient city of Pompeii, the *mofetes* are very frequent and powerful, so that the excavations that are carrying on there are often interrupted by them; at all times *mofetes* are to be met with under ancient lavas of Vesuvius, particularly those of the great eruption of 1631. In Serao's account of the eruption of 1737, and in the chapter upon *mofetes*, he has recorded several curious experiments relative to this phænomenon. The Canonico Recupero, who, as I mentioned to you in a former letter, is watching the operations of Mount Etna, has just informed me, that a very powerful *mofete* has lately manifested itself in the neighbourhood of Etna; and that he found, near the spot from whence it rises, animals, birds, and insects, dead, and the stronger sort of shrubs blasted, whilst the grass and the tenderer plants did not seem to be affected. The circumstance
of

of this *mofete*, added to that of the frequent earthquakes felt lately at Rhegio and Messina, makes it probable that an eruption of Mount Etna is at hand.

I am alarmed at the length of this letter. By endeavouring to make myself clearly understood, I have been led to make, what I thought, necessary digressions. I must therefore beg of your goodness, that, should you find this memoir, in its present state, too tedious (which I greatly apprehend) to be presented to our respectable Society, you will make only such extracts from it as you shall think will be most agreeable and interesting. I am,

SIR,

With great truth and regard,

Your most obedient

humble servant,

W. HAMILTON.

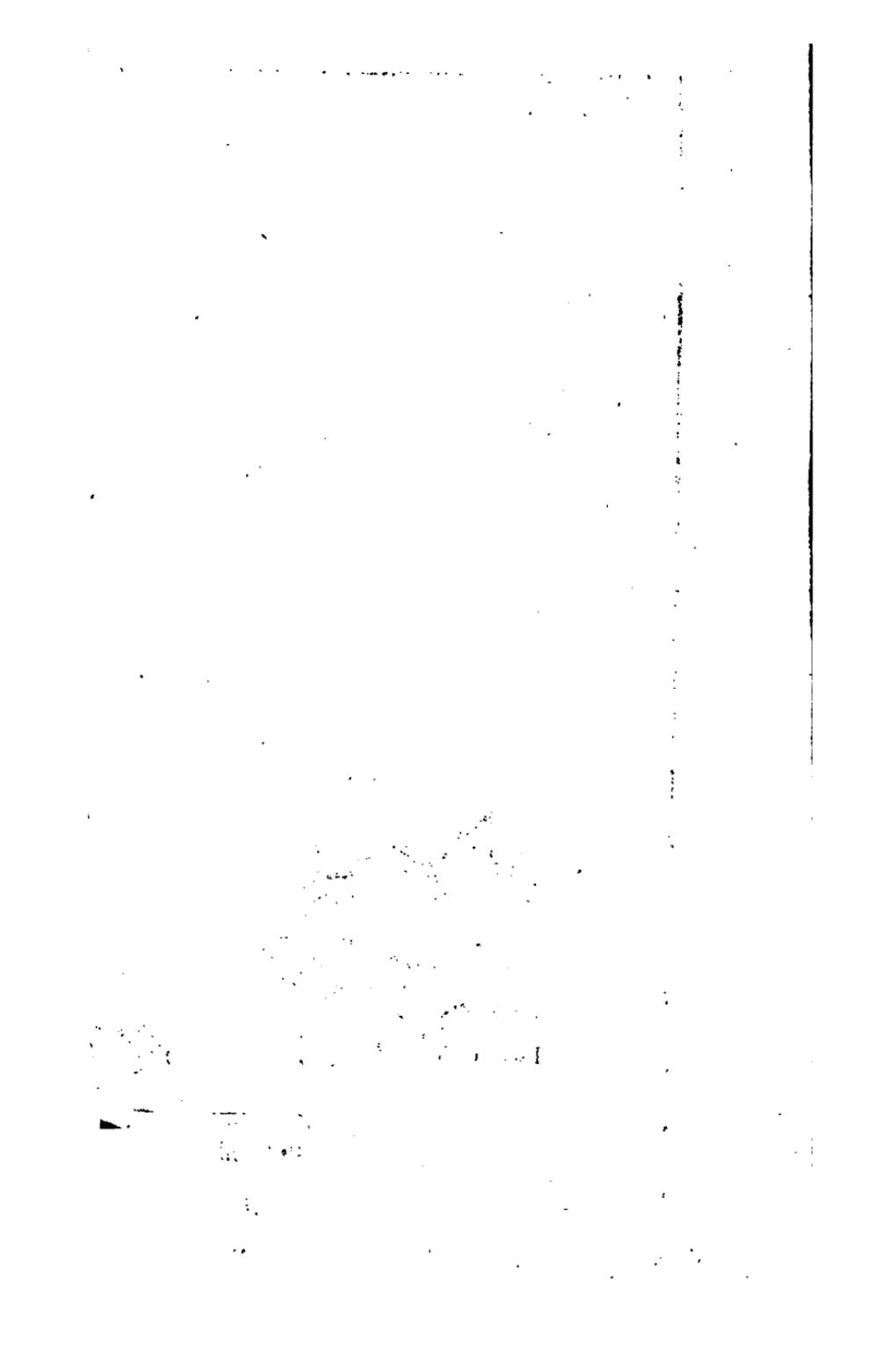
M 4.

REFER-

REFERENCES to the MAP,
[PLATE VI.]

1. Naples.
2. Portici.
3. Resina, under which Herculaneum is buried.
4. Torre del Greco.
5. Hermitage, at which travellers usually rest, in their way up Mount Vesuvius.
6. St. Angelo, a convent of Calmoldolese, situated upon a cone of a mountain formed by an ancient explosion.
7. Cones formed by the eruption of 1760, and lava that ran from them almost into the sea.
8. Mount Vesuvius and Somma.
9. Village of Somma.
10. The convent of the Madona del Arco, under which lavas have been found at 300 feet depth, and which must have





have proceeded from the mountain of Somma, when an active Volcano.

11. Ottaiano.
12. Torre del Annunziata,
13. Castel a Mare, near which the ancient town of Stabia is buried, and where Pliny the elder lost his life.
14. Vico.
15. Sorrento, and the plain formed evidently by subterraneous fire,
16. Massa.
17. Island of Caprea.
18. The Grotto of Pausilipo, cut through the mountain anciently, to make a road from Naples to Puzzole.
19. Point of Pausilipo.
20. The Gaiola, where there are ruins of ancient buildings, supposed to have belonged to Lucullus.
21. The island of Nisida, evidently formed by explosion.
22. The Lazaret.
23. The Bagnoli.
24. Puzzole, or Pozzuolo.
25. The

25. The Solfaterra, anciently called Forum Vulcani : between the Solfaterra and the lake of Agnano, are the boiling waters of the Pisciarelli.
26. The New Mountain, formed by explosion in the year 1538 ; the sand of the sea shore at its basis burning hot.
27. The lake of Agnano, supposed the crater of an ancient Volcano : here are the baths called St. Germano, and the famous Grotta del Cane.
28. Afruni, which has been evidently a Volcano, and is now a Royal Chace, the crater being surrounded with a wall.
29. The Monte Gauro or Barbaro, anciently a Volcano.
30. The lake of Avernus, evidently the crater of an ancient Volcano.
31. Lake of Fusaro.
32. Point of Misenum, from whence Pliny the elder discovered the eruption of Vesuvius that proved fatal to him ;

near this place, in a vault of an ancient building, is a constant vapour, or *mofete*, of the same quality with that of the Grotto del Cane.

33. The Mare Morto, the ancient Roman Harbour.
34. Baia; behind the castle are two evident craters of ancient Volcanos.
35. Island of Procita.
36. A perfect cone and crater of a Volcano near Castiglione in the island of Ischia.
37. Lava that ran into the sea in the last eruption on this island, in the year 1301, or 1302: the place now called Le Cremate.
38. Town of Ischia and castle.
39. Lake of Licola.
40. Lake of Patria.
41. The river Voltumnus.
42. Capua.
43. Caserta.
44. Aversa.
45. Mataloni,

46. Acerra.

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46. Acerra.
47. Island of Ischia, anciently called, *Aenaria, Inarime, and Pithecusa.*
48. The mountain of St. Nicola, anciently called Mons Epomeus, supposed the remains of the principal Volcano of the island.
49. Castiglione, near which are the baths of Gurgitelli.
50. Lacco, near which is that very cold vapour called by the natives *ventarole.*
51. Ancient city of Pompeii, where his Sicilian Majesty's excavations are carrying on at present.
52. Rovigliano.
53. River of Sarno.
54. Cuma.
55. Hot sands and sudatory, called Nero's baths.
56. The Lucrine lake, supposed to have been here, and of which there is still some little remain.
57. Villa Angelica, Sir William Hamilton's villa, from whence he has made many

many of his observations upon Mount Vesuvius.

58. Cones formed by an ancient eruption called *viuli*; here are likewise cold vapours called *ventaroli*.
59. High grounds, probably sections of cones of ancient Volcanos, being all composed of *tufa* and strata of loose pumice and burnt matter.
60. Plain of the Campagna Felice, four or five feet of excellent soil, under which are strata of burnt and erupted matter.
- Marks the boundary of Sir William Hamilton's observations.





LETTER VI[x].

To MATHEW MARY, M.D. Secretary to
the Royal Society.

Naples, March 5, 1774.

SINCE I had the pleasure of sending you my letter, in which the nature of the soil of more than twenty miles round this capital is described; examining a deep hollow way cut by the rain waters into the outside cone of the Solfaterra, I discovered, that a great part of the cone of that an-

[x] This letter was not received by Dr. Maty in its present form: and is rather the substance of an explanatory catalogue, which was sent to that gentleman with sundry specimens of the different materials that compose the soil described in the preceding letter; which catalogue remains, with the specimens, in the Museum of the Royal Society, for the inspection, and, I flatter myself, the satisfaction, of the curious in natural history.

cient

cient Volcano has been calcined by the hot vapours above described. Pumice calcined seems to be the chief ingredient, of which several specimens of (as I suppose) variegated unformed marble are composed, and the beautiful variegations in them may have probably been occasioned by the mineral vapours. As these specimens are now sent to the Royal Society, you will see that these variegations are exactly of the same pattern and colours as are met in many marbles and flowered alabasters; and I cannot help thinking that they are marble or alabaster in its infant state. What a proof we have here of the great changes the earth we inhabit is subject to! What is now the Solfaterra, we have every reason to suppose to have been originally thrown up by a subterraneous explosion from the bottom of the sea. That it was long an existing Volcano, is plain, from the ancient currents of lava, that are still to be traced from its crater to the sea, from the strata of pumice and erupted matter,

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matter, of which its cone, in common with those of other Volcanos, is composed, and from the testimony of many ancient authors. Its cone in many parts has been calcined, and is still calcining, by the hot vapours that are continually issuing forth through its pores; and its nature is totally changed by this chemical process of Nature. In the hollow way, where I made these remarks, you see the different strata of erupted matter, that compose the cone, in some places perfectly calcined, in others not, according as the vapours have found means to insinuate themselves more or less.

A hollow way, cut by the rains on the back of the mountain on which part of Naples is situated, towards Capo di China, shews that the mountain is composed of strata of erupted matter, among which are large masses of bitumen, in which its former state of fluidity is very visible. Here it was I discovered that pumice stone is produced from bitumen, which I believe

lieve has not yet been remarked. Some specimens shew evidently the gradual process from bitumen to pumice: and you will observe that the crystalline vitrifications, which are visible in the bitumen, suffer no alteration, but remain in the same state in the perfect pumice as in the bitumen.

In a piece of stratum, calcined from the outside of the Solfaterra, the form and texture of the pumice stones is very discernible. In several parts of the outside cone, this calcining operation is still carried on, by the exhalation of constant very hot and damp vapours, impregnated with salts, sulphur, alum, &c. Where the abovementioned vapours have not operated, the strata of pumice and erupted matter, that compose the cone of the Solfaterra, are like those of all the high grounds in its neighbourhood, which I suppose to have been thrown up likewise by explosion. I have seen here, half of a large piece of laya perfectly calcined, whilst the

N

other

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other half out of the reach of the vapours has been untouched; and in some pieces the centre seems to be already converted into true marble.

The variegated specimens then, above described, are nothing more than pumice and erupted matter, after having been acted upon in this manner by the hot vapours; and if you consider the process, as I have traced it, from bitumen to pumice, and from pumice to marble, you will think with me, that it is difficult to determine the primitive state of the many wonderful productions we see in Nature.

I found, in the *tufa* of the mountain of Pausilipo, a fragment of lava: one side I polished, to shew it to be true lava; the other shews the signs of the *tufa*, with which it is incorporated. It has evidently been rounded by friction, and most probably by rolling in the sea. Is it not natural then to imagine that there must have been Volcanos near this spot, long before the formation of the mountain of Pausilipo? This lit-